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PATTERNS OF CHILDREN'S PREFERENCES

by

© OLA HINTON BRADBURY

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Abstract

Seven hundred and twenty school-age children gave preference responses to all paired comparisons of the colors red, blue, and green. The pairs were presented successively in the general form XY, XZ, YZ, with various stimulus orders balanced. Observation was made of the frequencies of occurrence of each of the eight possible patterns of successively choosing between items in three pairs. Four of these eight patterns involve a _shifting_ response (i.e. a second-choice change in the direction of preference for the color which is common to the first two pairs). Two of these _shifting_ patterns are intransitive. Intransitive response patterns were found to decrease with age. Interactions were discovered between a decline in _shifting_ preferences and the form of _shift_ involved as well as between a decline in intransitive preferences and the form of intransitivity involved. The data indicate that various aspects of novelty exert the determining influence on the preference behavior of younger children, and that this response priority diminishes only when it comes in conflict with principles of logical development. The data are discussed in terms of the primitive patterns of the child's preferences and issues of cognitive development.

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Introduction

Transitivity of preferences. Mathematical psychologists have been much concerned with devising explanations for the failure of the transitivity rule in choice behavior. This rule requires the choice A>C following choices A>B, B>C.[1] Although behavior fits the rule fairly well overall, violations are sufficiently common as to require a general reliance on stochastic specification of the transitivity of choice (Davidson and Marchak, 1959). Stochastic transitivity assimilates an element of randomness into the rule by stating expectations in terms of proportions derived from behavior. Thus, if A is preferred to B not every time, but a certain proportion of the time, and B is preferred to C some proportion of the time, it is expected that A will be preferred to C by a corresponding proportion, the minimum value of which depends on the strength of the stochastic requirement. For weak stochastic transitivity, the minimum value of this expectation is .5; for moderate stochastic transitivity, the minimum value is the smaller of the other two proportions; and for strong stochastic transitivity, the minimum value is the larger of the other two proportions. This allows for a probabilistic statement of choice behavior.

Use of stochasticity at all poses a difficulty because its probabilistic nature is in conflict with the model of the rational man that lies behind the consistency principle, of which transitivity is one part. But even with the random element entered into the calculation, violations of derived transitive expectations have been demonstrated for the strong (Coombs, 1958) and even for the weak (Tversky, 1969) forms of

stochastic requirement. And yet transitivity of choice is generally held to be essential to rationality and to the model of man adopted by psychology and apparently by the layman (Tversky, 1969). Abelson (1964) describes decision theory as caught in a dilemma, obligated to a consistency model, compromised by probabilistic necessity, and set to the task of devising ingenious means by which the essence of transitivity may be saved in spite of its failures. In general it may be said that the assertion of much of the work in decision theory, of which the papers by Coombs (1958) and Tversky (1969) are representative, is that intransitivity of choice does not result from a failure of the rules of reason, but from the operation of inobvious variables in the stimulus or response aspects of the choice situation. Once these variables are taken into account, the disorder implied by intransitivity vanishes.

In Coombs' (1958) study, the subject was asked to choose from among sets of gray stimuli on the basis of the items' closeness to the subject's judgment of ideal gray. The object of the experiment was to relate a stimulus variable referred to as laterality to the connection between inconsistency of choice and psychological distance. Laterality refers to the positions of the stimuli being compared in relation to the reference point, in this case the individually established and variable "ideal" gray. The most pertinent finding was that transitivity was more vulnerable when the stimuli compared were bilaterally distributed in relation to ideal than when they were unilaterally distributed. For example, with evenly distributed stimuli VLG (very light gray), LG (light gray), MLG (medium light gray), MG (medium gray), MDG (medium dark gray), DG (dark gray), and VDG (very dark gray), and

an ideal point close to MG, about one quarter of the way between MG and MLG, frequent violations of strong stochastic transitivity are observed in comparisons involving LG, MLG, and MDG, but not in comparisons involving VLG, LG, and MLG. This occurs both because variations in the perceived positions of the bilaterally split items will change their relative positions to a much greater extent than will such variability involving unilaterally distributed items, and because crucial changes in the relation of bilaterally split items will be caused by choice-to-choice variability in the subject's ideal point.

Tversky's (1969) studies account for violations of transitivity of choice on the basis of complex aspects of a multidimensional stimulus context operating in relation to response strategies. The experiments were run to provide a demonstration of consistent violations of weak stochastic transitivity under the following conditions: there are a number of comparison items A-E (e.g. gambles, applicants for a position), each item is assigned values on a primary and secondary criterion-of-choice dimension (e.g. probability of win and amount of payoff; intellectual ability and emotional stability or social facility); values on the primary and secondary dimensions are negatively correlated; it is established that adjacent items (i.e. A and B, B and C) are not significantly different in values on the first dimension (i.e. A's I.Q. of 103 is not really lower than B's I.Q. of 105); the subject is told that judgment should be made on the basis of the primary dimension when a difference there is considerable, but on the basis of the secondary dimension when it is not; the subject is presented all adjacent items (i.e. AB, BC, CD, DE) followed by comparison of the most widely

separate items (i.e. AE). All this may be rather roundabout, but it does produce consistent violations of weak stochastic transitivity. It is not clear how frequently one might expect to encounter such coincidences of stimulus structure and response strategy, but Tversky avoids making a case that behavior as we find it is either transitive or intransitive.

Both Coombs' and Tversky's studies demonstrate what Abelson (1964) refers to as context effects on choice. The emphasis on choice context makes it clear that consistency is not as simple as the rule of logical transitivity would require. The stimuli in their comparisons produce relational stimulus variables which are not attributable to items separately, and response itself exerts influences on the context which alters the relationship of the stimuli. Factors of context such as these are investigated in the study to be reported here. In this case, however, measures are made of choice behavior as it is. No attempt is made to arrange behaviors of particular forms. And here the choices studied are those of various ages of children. The intent is to study the patterns of common personal preference behavior as it develops.[2]

Developmental issues. In addition to the choice theorists' interest in transitivity, and peculiarly separate from it, a substantial developmental literature on the transitive inference has accumulated. This developmental interest stems from the Genevan establishment of transitive inference as one of skills characteristic of concrete operational thought (Piaget and Inhelder, 1941; Piaget, Inhelder, and Szeminska, 1960). Piaget and his co-workers used a tower-building task requiring coordinated measurements to test the age and form of emergence

of the logical operation, A=B, B=C, therefore A=C (Piaget, Inhelder, and Szeminska, 1960). This task allows the coordination of the heights of two separate towers only by use of a middle term as a truly operational measuring device, which is the crux of the transitive inference. It is, thus, that transitivity of length is seen as critical to all measurement. In these original Genevan studies, it was found that the child does not gain complete competence for transitive measurement operations until between seven and eight and one half years of age.

Research and attendant controversy have focused on three closely related issues: the means by which the child's possession of the transitive skill may be reliably detected, the minimum age at which the skill is acquired, and the relation of transitive inference to the other characteristic indicators of concrete operational thought, such as conservation and class inclusion. The issue was raised by considerably discrepant findings for transitive inference age norms by the Genevans and those following their methodological procedures (particularly Smedslund) and Braine, who used quite different diagnostic procedures. Braine (1959) identified transitive competence in children of five to six years of age. According to Piaget's theoretical position, such subjects are still in a period of preoperational thought which does not allow transitive inference. The ensuing controversy with Smedslund (Smedslund, 1963b, 1965, 1966; Braine, 1964) serves mainly to illustrate the utter incomparability of the experimental procedures and diagnostic criteria of the two opposing sides.

In his first paper on the issue, Braine (1959) provided an entirely instrumental means by which the subject could employ the

inference. The Genevan findings had relied on verbal data. Braine first trained subjects to find candy under either the longer or the shorter of two demonstration sticks, with the subject able to make perceptual comparisons of the sticks' lengths. He then presented two sticks, A and C, one slightly longer than the other, but separated so as to avoid direct perceptual comparison, and announced that he would help the subject find some candy as he placed a stick B, of intermediate length, against each of the two comparison sticks in turn. This provided the information A>B and B>C, which can lead the subject to the candy by transitive inference. Braine observed that 50% of his subjects around five years of age solved the problem.

Smedslund (1963b) charged that Braine's procedure allowed false-positive classification of a number of pretransitive subjects on the grounds that some subjects could either have guessed the transitive answer, made a direct perceptual comparison of the sticks, or made use of so-called nontransitive hypotheses. The nontransitive hypotheses involve reaching the conclusion without use of all of the premise information, notably by judging A>C because A>B, without taking into account B>C.[3] An experimental procedure was proposed to diagnose the attainment of the inference without contamination by allegedly illegitimate response strategies. This procedure involved an ingenious combination of measures apparently devised to discourage detection of early instances of the inference. To insure that the transitive inference was strong, the comparison sticks were fitted with extensions to produce a Muller-Lyer illusion of greater length for the shorter stick. It was, thus, made necessary that the subject deny perceptual appearance to affirm his transitive judgment. Braine (1964) charged in his reply

that Smedslund had not made it clear to his subjects, for whom this Muller-Lyer evidence contradicted logical evidence, that the judgment was to involve actual as opposed to apparent length. In addition to overcoming the impediment of illusion, to be classified as transitive, the subject had to provide a proper verbal justification for his transitive judgment. It is hardly surprising that the age of minimal detection of transitive inference was raised to around eight by this procedure. It is a robust inference, indeed, that can survive the diagnostic abrasion. Smedslund has summarized his position on diagnosis of cognitive processes in a more recent paper (Smedslund, 1969). An opposing view has been offered by Brainerd (1972a). It is interesting to note that in a paper which appeared before the controversy with Braine, Smedslund (1960) recognises the difference between transitive behavior supported by the subject's verbal justification and "a purely functional transitivity". Braine (1959) is concerned with just such a functional transitivity, and clearly regards detection of it as the research problem.

The discrepant findings for the age of emergence of transitive operations is attributable to the various studies' use of non-comparable criteria for granting the presence of the inference. By analogy, we would hardly expect the same results from a discrimination task in which the subject is casually asked if two colors are different and one in which he is subjected to maximally sensitive psychophysical conditions. Differences in diagnostic procedures used by developmental psychologists attempting to talk about the same phenomena have been almost this exaggerated. In the tower building task (Piaget, Inhelder, and Szeminska, 1960), the criteria for granting fully operational use

of the transitive measurement inference required iterative application of a middle term smaller than the model. This drove the age of detection up to between seven and eight and one half years. But Piaget does not intend to convey that less versatile transitivity operations were not mastered earlier. In fact, the data reported suggest that much younger children would pass less stringent tests for the detection of transitive inference. For example, there is the now well known observation that children between the ages of five and seven commonly use their own bodies as middle terms in size comparisons of two separated objects. This procedure is not regarded as indicative of operational transitivity by the Genevans. For one thing, it is obviously inaccurate. The tower built by such means will not necessarily be the same height as the model. However, if we are really more interested in minimal age detections of transitive operations than in measurement, we may ask why the middle term is used at all if not for implicit transitive purposes. From the perspective of diagnostics, it may be maintained that it is unimportant that the middle term used by these children was operationally unsatisfactory or that there were more adequate measurement tools distributed. Perhaps under experimental conditions more conducive to the response, Braine's (1959) procedure for example, these body-measurers would be detected as transitive.

Somewhat more important than the question of precise ages in the acquisition of skills is the relation of the skills in the developmental sequence. The most obscure of these relationships has been that of transitivity and conservation. The research literature has been equivocal. The Genevans first maintained (Piaget and Inhelder, 1941) that transitivity and conservation were developed synchronously. Some

empirical support for this position has been reported (Lovell and Ogilvie, 1961). Later discussions (Piaget, Inhelder, and Szeminska, 1960) claimed that conservation was a necessary condition for transitive operations and, hence, preceded it in development. A number of studies have produced results consistent with this view (Smedslund, 1961, 1963b, 1964; Kooistra, 1963; McManis, 1969). Contrary to these findings, Brainerd (1972) recently obtained data indicating that transitivity precedes conservation. In this study, transitivity was the easiest and the earliest mastered of three common concrete operational skills, transitivity, conservation and class inclusion.

The essence of conservation is recognition that the critical aspect of a thing remains the same in spite of changes in its appearance or readjustments of its ingredients. For example, a ball composed of a certain amount of clay contains the same amount of clay after its shape is changed, and a one foot line is a one foot line regardless of what it is placed against or how it is bent.

To follow the argument that transitivity presupposes conservation, it is obvious that some sort of preservation or retention of the one foot line's length is a prerequisite of transitive operations using it as a measuring device. For the conclusion A>C to follow demonstrations of A>B, B>C, it must be established that B=B. There may be some question that the transitive use of the middle term B involves a true conservation of B's length since the B of the first comparison is not made to disappear or to change in appearance before the second comparison. Nevertheless, from the perspective of the Genevan argument, transitivity presumes conservation.

Different transitivity results would perhaps be obtained if the middle term demonstrations contained a clearer conservation element. The common A=B, B=C demonstration that provides the basis for the transitive length judgment A=C does not establish that the A=C inference would not fail if, after the A=B demonstration with straight lines, B were changed in form to match a crooked C for the A=C comparison. It seems likely that this A=C transitive inference with a clear conservation component might fail much more frequently than the usual transitivity problem with straight sticks. This could be the case for no other reason than an increase in number of operations in the task necessitated by the comparison of symmetrical and asymmetrical items. But failure at the more difficult crooked-stick transitivity-conservation problem would surely not be construed to mean that the child did not possess transitive inference. And yet some operation would have to be missing. The task would be failed either because of a lack of transitivity, which is unlikely in the light of other demonstrations, or a lack of conservation, which the Genevan argument maintains must precede transitivity, or because of some additive task difficulty. Possibly the Genevan argument is wrong, and conservation is the more difficult of the two skills.

From another perspective, it may be maintained that the conservation tasks commonly used contain a tacit transitivity operation. In the most widely known demonstration of conservation of mass, the child is shown two equal-sized balls of clay, and he makes the judgment that the two balls do, indeed, contain equal amounts of clay. Then one of the balls is flattened into another shape, and the child is asked if the balls still contain equal amounts of clay. To see the

transitive aspect of the problem, regard the procedure as containing three balls of clay: A and B, the original two balls; and C, the second ball after transformation. The conservation operation, thus, contains the judgments A=B (given), B=C (the conserving response), and A=C (a transitive response). The conserving step, B=C, cannot be converted into the criterion judgment without inferential integration with the no-longer-present A=B comparison. Contrary to the later Genevan statements on sequential acquisition of transitivity and conservation, this analysis would suggest the earlier appearance of transitivity. The inconclusiveness of findings pertinent to invariant sequences in the emergence of concrete operations seems partly attributable to a lack of clear analysis of the skills involved and how they are related.

Very little developmental research has dealt with transitivity of preferences. Virtually all such work involving transitivity has used inference as the dependent variable. The only reported work directly pertaining to the transitivity of children's personal preferences is Smedslund's (1960) study of the preference patterns of pre-schoolers. Even in that study, the concern is primarily with the children's inferences about the preferences of others rather than with the transitivity of their own preferences. In the main portion of his experiment, Smedslund showed subjects three cards, each containing drawings of a different pair of objects selected from among three objects (e.g. a toy bear and a doll on card number one, a toy rabbit and the same bear on card number two, and the doll and rabbit on card number three). In the first two cards' illustrations, a figure was shown pointing to one of the objects. For example, in the first card,

the figure pointed to the doll, and in the second card, the figure pointed to the bear. In the third card the figure pointed to neither of the two objects shown. The subject was told that the figure's pointings in the first two cards indicated preferences, and he was then asked to judge the object the figure would prefer in the third card. Selection of the doll is a transitive choice. Verbal explanations were required after judgments. The forty nursery school children who served as subjects were about evenly distributed in age between five years, four months and six years, nine months. The diagnostic criterion required four out of four judgments transitive and at least one partial explanation.[4] Eight of the subjects (i.e. 20%) passed the criterion, leading Smedslund to conclude that children of the age tested do not possess the transitive skills. The children's verbal explanations for these responses, as well as data obtained on their own preferences, suggested to Smedslund that the lack of transitivity was attributable to a general egocentrism in the subjects, in conformity with the Genevan theoretical position.

The only data directly pertinent to the study to be presented in this report was obtained by Smedslund from 16 of the 40 subjects in the study just discussed. After other measures had been taken, each of these 16 subjects was shown all paired comparisons of three objects, and asked to indicate a personal preference in each pair. Nine of the sixteen patterns of response obtained were transitive. Smedslund concluded from these data that the children's personal preferences, in keeping with their inferences concerning the preferences of others, were substantially intransitive. Only two critical remarks will be made concerning these results, so as not to anticipate the new data to be

reported in later sections of this paper. First, a sample of sixteen response patterns is much too small to permit conclusions concerning overall transitivity. A second observation is that the sixteen patterns obtained must have been distributed over the eight possible ways of responding to three pairs of choices, of which two or one-forth are intransitive.[5] This means that the distribution of response patterns obtained by Smedslund is not just less transitive than might have been expected (i.e. 75% transitive would have been expected by chance, so for evidence of logical operations, we might have expected more than 75% of such patterns), it is also considerably more intransitive than chance would accommodate (i.e. 44% of the responses are distributed over the one quarter of possible patterns which are intransitive). This means that the children's preferences are not only not as logically constrained as might be expected, they are substantially biased in the illogical direction. No explanation is offered for this, and ego-centrism cannot accommodate the data since its explanatory value stops at the point where a logical bias is not observed. An explanation is needed for the bias toward illogical response.

The research problem. Smedslund's (1960) report concerning the personal preferences of his subjects raises many questions. How would a substantial sample of children's preferences be distributed over the various forms of possible response? How are these forms and the empirical distributions of responses to them related to the developmental issue concerning transitivity? More specifically, just how transitive are children's personal preferences?

In two previous studies of the transitivity of children's preferences (Bradbury and Nelson, 1970; Bradbury, Nelson, and Andriotti,

1971) and in one study with adult subjects (Bradbury, 1970), this writer observed that adults' preferences for sets of colors are not perfectly transitive, but that they are considerably more transitive than such preferences given by children. It was further observed that the transitivity of children's color preferences increases with age through the primary school years. Interest was directed to the form taken by the developing logical aspect of response and the effects of choice context on the formal properties of this type of behavior.

The transitivity problem, in its various forms, is usually presented to the subject as three separate and different paired comparisons of three items (i.e. first A and B presented and a judgment made, then A and C presented and a judgment made, then B and C presented and a judgment made). The variable of interest is the set of three responses. The eight possible forms of response to the set of three paired comparisons are shown in Table 1. It is, of course, only in the third choice that the subject can respond intransitively. Intransitivity is, by definition, a contradiction of a relation established between the items in the first two choices. This relation is made possible by the repetition of one of the three compared items in the first two pairs (i.e. item A appears in both pairs: AB, AC).

Of the eight possible forms of response to the three-pair sequence involved in transitivity problems, only two forms are intransitive. The first two pairs for only four of the eight forms contain the premise relations necessary for transitivity and intransitivity. So, in a free-choice situation, only one half of the response forms can be intransitive. This is not an issue in traditional developmental work involving the inference since the experimental

Table 1

The eight sets of possible preference responses to a sequence of all paired comparisons of three items, with indication of the transitivity, nontransitivity, or intransitivity of the sets of responses. Shifting or non-shifting in each response form is also indicated. Shifting is responding differently in the second choice to the color common to the first two pairs of the three-pair choice sequence (i.e. x>y, x<z or x<y, x>z). These sets of responses are illustrated with only one of the six stimulus orders employed. t = transitive; c = cyclic or intransitive; nt = nontransitive.

Forms of Response							
1	2	3	4	5	6	7	8
X>Y	X<Y	X>Y	X<Y	X>Y	X<Y	X>Y	X<Y
X>Z	X<Z	X>Z	X<Z	X<Z	X>Z	X<Z	X>Z
Y>Z	Y<Z	Y<Z	Y>Z	Y<Z	Y>Z	Y>Z	Y<Z
nt	nt	nt	nt	t	t	c	c
no shift	no shift	no shift	no shift	shift	shift	shift	shift

procedure provides the first two comparisons in such a way as to force the transitivity problem on the subject (i.e. A>B, A<C presented and B?C requested). The four response forms in which the first two choices make intransitivity possible are distinguished from the other four forms by the nature of response to the stimulus item which is common to the first two pairs (i.e. stimulus item A in AB, AC). This is formally analogous to the middle term of transitive measurement tasks. The subject must shift his form of preference response to this item if he is to give an intransitive response in the third choice. Shifting is defined here as responding differently in the second choice to the item common to the first two pairs of the three-pair choice sequence (i.e. A>B, A<C or A<B, A>C). For purposes of the present study, two of the eight possible forms of response are shifting and transitive, two are shifting and intransitive, and four are non-shifting and are considered nontransitive since they are indeterminant so far as transitivity is concerned. The indeterminacy results from the failure of the first two choices of the sequence to establish an ordinal relation between all three items being compared.

One way of looking at the consistency of the choice situation is to note that there is more than one route to the avoidance of intransitivity. The subject may shift and then respond transitively, or he may avoid the possibility of intransitivity by not shifting. Previous data on tasks similar to the one reported here (Bradbury and Nelson, 1970; Bradbury, Nelson, and Andreotti, 1971) indicated that the intransitivity of children's preferences decreases with age and suggested that this could be partially attributed to a decreasing tendency to give shifting forms of response. It was expected that the

present study would confirm these findings and provide a more complete picture of the direction actually taken by children's preferences and the priorities taken into consideration as the child makes his choice. It was hoped that such a wide, empirical survey of children's preference responses would provide the material out of which a psychological model of developing preference might be built. It was obvious from both adult's and children's data that a logical model of behavior was not appropriate.

Method

Materials. Preference responses were given to all paired comparisons of the colors red, blue and green[6] in Munsell glossy finish papers: red, 5.0 R 4/14; blue, 5.0 PB 5/12; green, 2.5 G 5/12. These are highly saturated hues of medium lightness to which there is a relatively consistent application of common color names by adults (Chapanis, 1965).

A four-page booklet was provided for each subject. The first page contained samples of the colors orange (2.5 YR 6/16) and purple (5 P 3.9/10.9 max). The following three pages paired red, green, and blue samples in all three possible ways, with a different pair shown on each page. The color samples were $1\frac{1}{2}$ inch squares. They were mounted side by side on plain white paper separated by approximately three inches. Approximately two inches beneath each color sample was a blank square the size of the colors.

A sample of the booklets used is given in Appendix A. Unlike the sample given in the appendix, the booklets used in the study were stapled in the upper left hand corner, the page size was shorter (e.g. approximately $7\frac{1}{2}$ inches long), the squares were in purple ink of the ditto machine type, and on the back of the last page appeared the subject's first name and a numbered indication of the way the three colors were ordered in pairs in that booklet.

The three colors can be applied to the paired form, XY, XZ and YZ in six different orders, as shown in Table 2. In addition, there are a number of variations possible in the left-right position of items in pairs. To control for a possible influence of position preference on consistency, one quarter of each of the subjects, with

Table 2

The six possible orders of three stimuli, X, Y, Z, applied to the six sets of exhaustive paired comparisons.

	Stimulus Orders					
	1	2	3	4	5	6
	XYZ	XZY	YXZ	YZX	ZXY	ZYX
1st choice pair	XY	XZ	YX	YZ	ZX	ZY
2nd choice pair	XZ	XY	YZ	YX	ZY	ZX
3rd choice pair	YZ	ZY	XZ	ZX	XY	YX

sexes balanced, were presented the color pairs in each of the four orders shown in Table 3. Details of the position preference issue for this procedure are given in Appendix B. Table 4 shows the 24 sets of balanced stimulus orders that were used.

Subjects and procedure.[7] In the main portion of the study, 720 grade school children, divided into three ages as represented in grades one, three, and five, were assigned in equal numbers, with sexes balanced, to the twenty-four stimulus conditions of Table 4. Each stimulus condition at each age was, thus, assigned five boys and five girls. The median ages of the three main groups were as follows: age one, six years, ten months; age two, eight years, eleven months; age three, ten years, eleven months.

Subjects were run in groups. At the beginning of the session, booklets were distributed to subjects arranged in their usual classroom seating. Subjects were asked not to look through the booklets. Instructions indicated that the experimenter was trying to learn what colors children like best, and that the booklets would allow the class to show their color preferences. The group was told, with demonstration made from the front of the room, that the first page of the booklet showed two colors, and that a box appeared beneath each of these colors. They were asked to choose the preferred color on that page and to make an x in the box beneath it. Subjects were asked not to pay attention to the choices made by their neighbors on the grounds that the only question of interest was the color they, themselves, preferred. Efforts were made by the experimenter and by the classroom teacher to see that the subjects did not look at each other's booklets or communicate with each other.

Table 3

The four left-right orders of stimuli in pairs used in the study of children's preference patterns. An equal number of subjects, with sexes balanced, was assigned to each of the four pair orders applied to each of the six stimulus orders shown in Table 2. The letters X, Y, and Z refer to the colors red, green, and blue in any of the orders of Table 2.

#2	#3	#6	#7
left right	left right	left right	left right
XY	XY	YX	YX
XZ	ZX	XZ	ZX
YZ	YZ	ZY	ZY

Table 4

All sets of stimuli used in the study of children's preference patterns. Five children of each sex at each of the three ages tested were assigned to each of the 24 sets shown. R=Red, G=Green, B=Blue.

The six stimulus orders of Table 2	The four pair orders of Table 3: 2	3	6	7
1	RG RB GB	RG BR GB	GR RB BG	GR BR BG
2	RB RG BG	RB GR BG	BR RG GB	BR GR GB
3	GR GB RB	GR BG RB	RG GB BR	RG BG BR
4	GB GR BR	GB RG BR	BG GR RB	BG RG RB
5	BR BG RG	BR GB RG	RB BG GR	RB GB GR
6	BG BR GR	BG RB GR	GB BR RG	GB RB RG

After the first choice had been made, the subjects were told that they should turn the page, being careful to turn only one page, and indicate, in the same way, the color preferred on the second page. They were then told to continue this procedure until a response had been made on all pages. Subjects were told that they should not look back through the booklet before making a choice and that they should not go back and change a choice made earlier.

Preference-inference condition. Two classroom groups at each of the age levels tested were shown enlarged versions of the second and third booklet pages for stimulus condition 1-2 of Table 4 with answers marked R>G, R<B. This demonstration was made in the classroom. These groups were told that another class had preferred the colors marked. A single booklet page showing green and blue had been distributed to the subjects before the demonstration was made. After the demonstration, subjects were asked to mark on the sheets provided the third-choice color they thought the other class had preferred. They were told to guess if they could not figure out the answer. Both left and right positions of green and blue on the response sheets were used. The demonstration choices R>G, R<B, were displayed while the subjects deliberated and made responses. For this condition, Age one, n=42, median age = seven years; Age two, n=74, median age = nine years, two months; Age three, n=52, median age = eleven years, two months.

Preference-inference condition with verbal explanations: 22 children of the youngest age level tested were run individually in the preference-inference condition just described. The subject sat in a student desk with the green-blue answer sheet in front

of him as the experimenter made the demonstration of the alleged other class's preferences, R>G, R<B. He was then asked which color he thought the other class preferred between those shown on the answer sheet. After he had marked his answer, if the answer was transitive, he was asked why he thought the class had preferred that color over the other one. This explanation was also requested of some of the subjects who gave intransitive responses. Just before being dismissed, each of these subjects was asked which of the two colors on the answer sheet (i.e. green and blue) he personally preferred. The ages of these 22 subjects are listed individually in the Results section of this report along with their response data. The median age was seven years.

A total of 910 children served as subjects in this experiment.

Results and Discussion

Table 1 shows the eight possible forms of response to the series of pairs presented. It is on the basis of the eight response forms of Table 1 that the subjects' preferences are compred. The tables which make up Appendix C show as frequencies all responses given under each experimental condition. These are the basic data. Table 5 shows the distribution of responses to each form for each age group with stimulus conditions combined. Table 6 shows the proportion of responses at each option in the series of three choices.

Chi Square tests were used to compare responses of the various response forms. A large number of Chi Square tests were made on the data. They are summarized in Appendix D. The tests are not all independent, which raises the chance that some result may be unjustifiably reported as significant. However, the data are discussed in terms of patterns of difference. Great reliance is not made on any one difference. Also, significance levels are, for the most part, quite high (i.e. $P<.001$). The main results to be discussed do not depend on marginally detected differences. Table 7 shows the results of the Chi Square tests which relate to the data presented in Table 6. The data will be discussed in terms of first, second, and third choice results and influences.

The First Choice. Interpretation of the data involves observations of discrepencies between what might be expected from the subjects' behavior and what actually occurred. The issue behind the research is a contention that preference behavior is not primarily reasonable or logical, that this can be demonstrated by the departure

Table 5

Distribution, over the eight possible forms of response, of the preference responses of three ages of children for all paired comparisons of the three colors, red, green, and blue. Median ages: Group one, 6;10, Group two, 8;11, Group three, 10;11.

	Forms of response (see Table 1)								
	1	2	3	4	5	6	7	8	
Age group one (n=240)	.04	.17	.03	.19	.08	.08	.32	.09	proportions of 240 responses
Age group two (n=240)	.04	.19	.03	.24	.10	.06	.28	.06	proportions of 240 responses
Age group three (n=240)	.10	.15	.05	.18	.19	.08	.18	.07	proportions of 240 responses
Totals (n=720)	.06	.17	.04	.20	.13	.08	.26	.07	proportions of 720 responses

Table 6

All preference responses by children of three ages to exhaustive paired comparisons of three colors (n=240 for each age). Shown are the choices possible at each step in the three-choice sequence, the logical expectations of responses, and the proportions of responses to those options. Also shown are responses by adult subjects (n=84) for a similar task. The two intransitive third choices are indicated by c, for cyclic, and the intransitive sequences are shaded. Median ages: Group one, 6;10, Group two, 8;11, Group three, 10;11. Adults were university undergraduates.

FIRST CHOICES	x>y	x<y
LOGICAL EXPECTATIONS	.50	.50
AGE 1 RESPONSES	.47	.53
AGE 2 RESPONSES	.45	.55
AGE 3 RESPONSES	.52	.48
AGES COMBINED	.48	.52
(ADULTS IN A SIMILAR STUDY)	(.46)	(.54)

SECOND CHOICES	x>z	x<z	x>z	x<z
LOGICAL EXPECTATIONS	.50	.50	.50	.50
AGE 1 RESPONSES	.15	.85	.32	.68
AGE 2 RESPONSES	.15	.85	.22	.78
AGE 3 RESPONSES	.27	.73	.31	.69
AGES COMBINED	.19	.81	.28	.72
(ADULTS IN A SIMILAR STUDY)	(.49)	(.51)	(.27)	(.73)

THIRD CHOICES	y>z	y<z	y>z	y<z	y>z	y<z	y>z	y<z
LOGICAL EXPECTATIONS	.50	.50	.0	1.0	1.0	.0	.50	.50
AGE 1 RESPONSES	.53	.47	.79	.21	.49	.51	.53	.47
AGE 2 RESPONSES	.56	.44	.73	.27	.48	.52	.56	.44
AGE 3 RESPONSES	.68	.32	.49	.51	.56	.44	.54	.46
AGES COMBINED	.61	.39	.67	.33	.51	.49	.54	.46
(ADULTS IN A SIMILAR STUDY)	(.74)	(.26)	(.25)	(.75)	(.67)	(.33)	(.36)	(.64)
FORM OF RESPONSE (TABLE 1)	1	3	7 c	5	6	8 c	4	2

Table 7

Summary of results of Chi Square tests on comparisons of preference responses shown in Table 6. These are preferences of children of three ages for exhaustive paired comparisons of three colors. Shown are proportions of responses for each option, with respective frequencies in parentheses. Chi Square results appear between sets of figures compared and along the sides of columns for age comparisons. The Chi Square tests are summarized in Appendix D.

FIRST CHOICES

	Age comparison	x>y		x<y
LOGICAL EXPECTATIONS		.50		.50
AGE 1 RESPONSES	n.s.	.47(113)	n.s.	.53(127)
AGE 2 RESPONSES	n.s.	.45(107)	n.s.	.55(133)
AGE 3 RESPONSES	n.s.	.52(124)	n.s.	.48(116)
AGES COMBINED		.48(344)	n.s.	.52(376)

SECOND CHOICES

	x>z		x<z	Age comparison	Age comparison	x>z		x<z
LOGICAL EXPECTATIONS	.50		.50			.50		.50
AGE 1 RESPONSES	.15(17)	p<.001	.85(96)	p<.05	n.s.	.32 (41)	p<.001	.68 (86)
AGE 2 RESPONSES	.15(16)	p<.001	.85(91)	p<.05	n.s.	.22 (29)	p<.001	.78(104)
AGE 3 RESPONSES	.27(34)	p<.001	.73(90)	p<.05	n.s.	.31 (36)	p<.001	.69 (80)
AGES COMBINED	.19(67)	p<.001	.81(277)			.28(106)	p<.001	.72(270)

THIRD CHOICES

	Age comparison	y>z		y<z	Age comparison	y>z		y<z
LOGICAL EXPECTATIONS		.50	followed	.50		.0	reversed	1.0
AGE 1 RESPONSES	n.s.	.53 (9)	n.s.	.47 (8)	p<.001	.79 (76)	p<.001	.21(20)
AGE 2 RESPONSES	n.s.	.56 (9)	n.s.	.44 (7)	p<.001	.73 (66)	p<.001	.27(25)
AGE 3 RESPONSES	n.s.	.68(23)	p<.05	.32(11)	p<.001	.49 (44)	n.s.	.51(46)
AGES COMBINED		.61 (41)	n.s.	.39(26)		.67(186)	p<.001	.33(91)
FORM OF RESPONSE (TABLE 1)		1		3		7 c		5

	Age comparison	y>z		y<z	Age comparison	y>z		y<z
LOGICAL EXPECTATIONS		1.0	not followed	.0		.50	followed	.50
AGE 1 RESPONSES	n.s.	.49(20)	n.s.	.51(21)	n.s.	.53 (46)	n.s.	.47(40)
AGE 2 RESPONSES	n.s.	.48(14)	n.s.	.52(15)	n.s.	.56 (58)	n.s.	.44(46)
AGE 3 RESPONSES	n.s.	.56(20)	n.s.	.44(16)	n.s.	.54 (43)	n.s.	.46 (37)
AGES COMBINED		.51(54)	n.s.	.49(52)		.54(147)	n.s.	.46(123)
FORM OF RESPONSE (TABLE 1)		6		8 c		4		2

of behavior from a logical model, and that a psychological model of preference is needed. Behavior is considered against a logical standard with adoption of the naive expectation that the influences we hope to observe are not present.

From this perspective, we should expect proportions of responses of forms 1,3,5,7 to be equal to those of forms 2,4,6,8. In other words, with the three colors balanced over the x,y,z arrangements so, that x is red, green, and blue equally (and so forth for y and z), we should expect x to be preferred to y in the first pair about half the time for all age groups. Chi Square tests failed to detect response differences related to ages for these forms. Chi Square tests at each age separately and for the ages combined also failed to detect significant differences. Though this is an obvious expectation, other similarly logical positions are not supported by the data.

The Second Choice. So long as colors are applied equally to the x,y,z forms, we should logically expect the following distribution of proportions of responses to forms: 1+3 = 2+4 = 5+7 = 6+8. At issue is the second choice. It has already been established that it is equally likely that x will be preferred or not preferred in the first choice. Color x is the color which is common to the first two pairs of the three-pair choice sequence. It should be equally likely that x will be selected or rejected in the second choice after having been selected or rejected in the first choice.[8] Color x, being any of the colors used, has been compared to another color in the first pair. In the second pair, x will be compared to a third color. This third color, which also can be any color used, should be preferred and not preferred equally often

regardless of the relationship established between x and some other color just prior. Behavior does not follow this logical principle at all.

Results. Table 8 shows the forms of response, logical expectations, and distributions of responses for the three ages of subjects for the first two of the pairs in the series. These second-choice data are given in different form in Table 6. The data show that, for all ages of children tested, it is extremely unlikely that a color will be preferred twice in a row (regardless of the other color with which it is paired). This conclusion is supported by the results of separate Chi Square tests at each age and for the three ages combined comparing response forms 1+3 (selection of x after selection of it) with response forms 5+7 (rejection of x after selection of it) ($P<.001$ for each comparison). It is also unlikely that a color not preferred in the first pair will be preferred when it appears again in the second pair. Separate Chi Square tests at each age and for the ages combined compared response forms 2+4 (x not preferred after not having been preferred) with forms 6+8 (x preferred after not having been preferred). The results were significant ($P<.001$ for all comparisons). It is likely either that a color will be preferred first and then not preferred when it appears again, or that it will be rejected and then rejected again.

A shift has been defined as a response (prefer, not prefer) to color x in the second pair which is unlike the response to that same color in the first pair. Shifts are of two types: selecting x in the first pair and rejecting it in the second pair, or rejecting x in the

Table 8

Distributions, over the eight possible forms of response, of the proportions of preference responses of children of three ages to the first two in a series of three (i.e. exhaustive) paired comparisons of three colors. For each age group, n=240.

Response forms (Table 1)	1+3	2+4	5+7	6+8
1st pair 2nd pair	x preferred x preferred	x not preferred x not preferred	x preferred x not preferred	x not preferred x preferred
Logical expectation	.25	.25	.25	.25
Response proportions				
Group one (median age = 6;10)	.07	.36	.40	.17
Group two (median age = 8;11)	.07	.43	.38	.12
Group three (median age = 10;11)	.15	.33	.37	.15
Totals (n=720)	.09	.38	.38	.15

first pair and selecting it in the second pair. It is only after a shifting second-choice response that the subject can respond intransitively in the third choice. It had been observed from previous studies that elder children give fewer intransitive subjective preference responses than do younger children (Bradbury and Nelson, 1970; Bradbury, Nelson, and Andreotti, 1971) and that adults provide fewer shifting responses than do children (Bradbury, 1970). It was expected that the elder child's decrease in intransitive response would be partly attributable to a lower proportion of shifting responses. However, overall this decrease was not observed. A Chi Square test did not detect a shifting/non-shifting response difference related to age for these data ($.20<P<.30$). The relation between shifting and age is shown in Table 9 and in Figure 1a.

The data of Table 8 indicate, however, that second-pair shifting/non-shifting is not simple, but depends on which color was chosen in the first pair. Children frequently shift when they have preferred the color in the first pair which is to appear again in the second pair (.81). When they have not preferred this color in the first pair, they shift much less frequently (.28). A Chi Square test supports this observation of a relation between shifting and the type of shift involved ($P<.001$).

Discussion. These data show a possible predominance of negation or rejection in the preference responses of children. Though none of these responses was requested to be in rejection form, and all instructions were given in terms of selection of the color liked best, there is a suggestion that children's preference responses may be guided

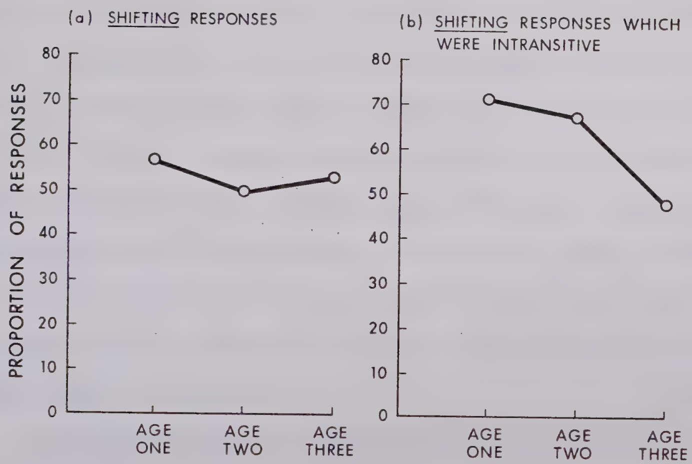
Table 9

For the preference responses by children of three ages to exhaustive paired comparisons of three colors, the proportions of responses in which a shift occurred, the proportions of these shifting responses which were transitive, and the proportion of intransitive responses in relation to all responses. Shifting is responding differently in the second choice to the color common to the first two pairs of the three-pair choice sequence (i.e. x>y, x<z or x<y, x>z). Median ages: Group one, 6;10, Group two, 8;11, Group three, 10; 11. For each age group, n=240.

	Proportion of responses shifting	Proportion of shifting responses which were transitive	Total proportion of intransitive responses
Age group one	.57	.29	.40
Age group two	.50	.33	.34
Age group three	.53	.52	.25

Figure 1

Proportions of shifting preference responses given by children of three ages to exhaustive paired comparisons of three colors, and the proportions of these shifting responses which were intransitive. A shift is a response (prefer, not prefer) to color X in the second pair which is unlike the response to that same color in the first pair. Color X is the color which is common to the first two pairs of the three-pair choice sequence. Median ages: Group one, 6;10, Group two, 8;11, Group three, 10;11. For each age group, n=240.



by a principle of rejection. Once having chosen a color, a child will very likely reject it if it appears in the next choice (i.e. he will choose any other color over it). In this study children responded in this way on 81% of the opportunities they had to do so. However, if they do not prefer a color in the first pair, and it is presented again in the second pair, children are very likely to reject it again. This response was given on 72% of the opportunities. The subjects did not merely respond differently to the second pair. They did this only when the second pair contained a color previously preferred. If they had rejected the color which reappears in the second pair, they most often gave the same response in relation to that color again.

The color x, the color common to the first two pairs, may be the key to the response patterns. In general we can say that once chosen, it is not chosen again, and once rejected, it is rejected again. However, it could be either that the child anchors his response on the x color, or that he tends to choose the color not seen before. In the first choice, the child sees x and another color, with no indication that x will be seen again. In this first pair, x is chosen about half the time. In the second choice, he sees x and a color not seen before. In the second pair, this new color is chosen, not half the time, but 77% of the time.

It could be that the child's response is not keyed on color x (i.e. rejection) but on the new color, color z (i.e. selection). Looking only at second-choice data, it is difficult to see how these two potential contributors to the result could be completely disentangled since selection of one color involves rejection of the

other. Selection of color z may be based on its novelty. A novel stimulus/novel response explanation for this pattern of response in the first two choices will be offered when consideration has been given to the data for the third choice.

Age differences appear at this point in the three-choice series only in the eldest group's increase in selection of a color in the second choice after selection of that same color in the first choice. A Chi Square test indicated an age effect in differences in response forms 1+3 and 5+7 ($P<.05$). The two younger age groups gave virtually identical (.85) proportions of response to forms 5+7 in this situation. The age effect is, thus, attributable to the eldest group's lower frequency of response to these forms.

The relation between shifting in the second choice and preference for the color x in the first choice requires discussion. Intransitive responses are inconsistent and have traditionally been considered irrational. In this series of three preference responses, shifting in the second choice is not, in itself, inconsistent, but it is in the service of inconsistency since it is only after shifting that a subject can respond intransitively in the final choice. In a sense, non-shifting responses assist supposedly rational behavior in that they make intransitive responses impossible. Yet we find that shifting or non-shifting is not directed by any apparent rational principle. It is largely determined by whether the color in the first pair which is to appear in the second pair is selected or rejected in the first response, and this seems to be a matter of chance. If it is selected in the first pair, the child will probably reject it

in the second pair and, thereby, leave himself open to the possibility of intransitive response in the third choice. If this color is rejected in the first choice, the child is probably safe, so to speak, because he will very likely reject it again regardless of what is presented with it. After this response, he cannot respond intransitively. In the first choice of the series, the child unwittingly contributes to the consistency or inconsistency of his later choices. This may be described as a first-choice influence. In the second choices, the subject establishes the premises against which his last choice will be evaluated. If he shifts the x relation, he brings logic into question and creates a new set of choice contingencies for later comparisons. These contingencies are referred to as second-choice influences.

The Third Choice. It was maintained that, barring influences arising out of the earlier choice or from context effects, the two colors in the second pair should be equally preferred. Such a claim cannot be made for the third choices since, in two instances, the preceding responses have implied a relationship between the colors of the third pair. There should be different logical third-choice expectations for the four different forms of response to the first two pairs. Colors y and z should be preferred equally frequently after color x has been preferred to both of them (response forms 1 and 3). This should also be the case after colors y and z have each been preferred to color x (response forms 2 and 4). However, we should expect color z to be chosen over color y after x has been preferred to y, and z has been preferred to x (response forms 5 and 7). And color y should be

preferred to color z after y has been preferred to x, and x has been preferred to z (response forms 6 and 8). Response expectations, in their completely logical forms are shown in Table 6.

Results. Tables 5 and 6 show the response distributions for the four sets of third-choice options. Logical expectation for third choices was followed only in the two sets in which transitivity was not at issue, and in one of these it is questionable. A Chi Square test comparing response forms 1 and 3 for the three age groups failed to detect significant differences ($.50<P<.70$). Separate Chi Square tests on response at each age and with the ages combined detected differences only for the eldest group tested (Age one, $.80<P<.90$; Age two, $.50<P<.70$; Age three, $P<.05$; Ages combined, $.05<P<.10$). Logical expectations would not call for differences in this choice, in which the two colors should be equally preferable. However, once they have chosen x over y and x over z, elder children are more inclined to choose y than z. This cannot be said of younger children.

The 1/0 expectations for response forms 5 and 7 are derived from the logical constraint of the transitive relation. It is here that behavior is in clearest violation of the model. In no group does the transitive constraint achieve a predominance of form 5 response. The closest is transitive .51 by the eldest group, a proportion that is virtually one half. A Chi Square test on form 5 and 7 responses by the eldest group failed to detect a significant difference ($.80<P<.90$).

Logic is so far from controlling behavior that, in fact, the younger subjects responded intransitively most of the time when faced

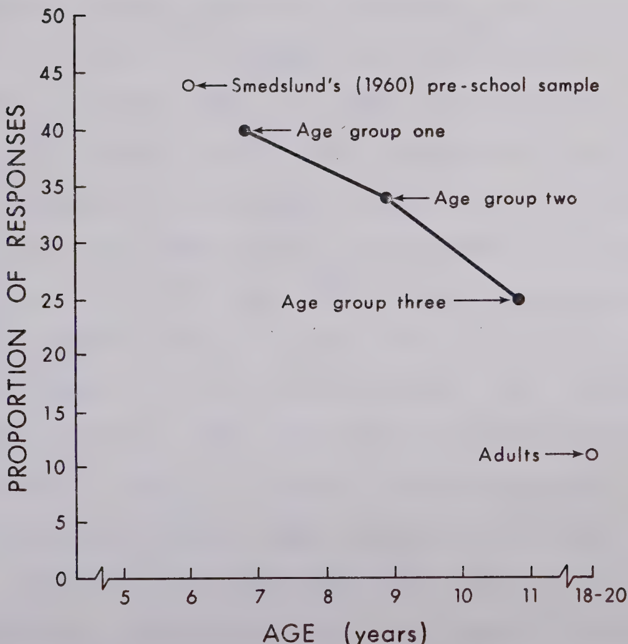
with the form 5 and form 7 choice. The proportion is intransitive .76 for the two younger groups combined. Separate Chi Square tests on forms 5 and 7 by the two younger groups both indicated significant differences ($P<.001$ for both). An age difference was also indicated by a Chi Square test comparing these responses for all three groups ($P<.001$).

The other logical constraint response forms are 6 and 8. Response to these forms is .51/.49, overall, which was not detected as significantly different ($.80<P<.90$). A significant age difference was not found for response to forms 6 and 8 ($.70<P<.80$).

The study was suggested by previous observations that intransitivity of preference decreases with age and by interest in the form this decrease takes. The data presented here support these general expectations regarding age and intransitivity of preference. A Chi Square test comparing response to forms 7 and 8 (intransitive) with response to all other forms for the three ages indicated significant differences ($P<.01$). Table 9 and Figure 2 show the decrease in intransitive choice with age. It might be noted that Smedslund (1960) reports 44% of his subjects' preferences as intransitive. It appears from the report that this sample's average age must have been around six years, one month, which makes them about nine months younger than the youngest group reported here. The youngest group here gave 40% intransitive responses. As Figure 2 shows, Smedslund's finding fits the age trend of the current data. There were, however, diagnostic differences which make a comparison of the data questionable.

Figure 2

Proportions of intransitive preference responses by children of three ages to exhaustive paired comparisons of three colors. Median ages: Group one, 6;10, Group two, 8;11, Group three, 10;11 months. For each of these three groups, n=240. Also shown are the proportions of intransitive preferences reported by Smedslund (1960) for pre-school children and by Bradbury (1970) for adults.



In general, children responded with intransitive preferences more frequently than would be expected by chance alone. Chi Square comparisons of response forms 7+8 (intransitive) with the other six forms indicated significant differences from a .25 expectation for all age groups combined ($P<.001$), as well as for age one ($P<.001$) and age two ($P<.01$), but not for age three ($\chi^2=0$). The age effect, already reported, was significant ($P<.01$).

The breakdown of intransitive choices is more complicated than would appear from these differences. There are two forms of intransitive preference response. All groups gave more form 7 intransitive responses than would be expected by chance, using an expectation of 1/8 of all responses (Age group one, $P<.001$; Age group two, $P<.001$; Age group three, $P<.01$, Ages combined, $P<.001$). There is also a significant age effect ($P<.01$), indicating that the elder children provided form 7 responses less than younger children even though they provided these responses more frequently than chance would accommodate. On the other hand, form 8 intransitive responses were given less frequently than a 1/8 expectation by all but the youngest group (Age group one, $.05<P<.10$; Age group two, $P<.01$; Age group three, $P<.01$, Ages combined, $P<.001$). Age differences were not detected to be significant ($.50<P<.70$). In general, then, children give one form of intransitive response quite frequently and the other infrequently.

Intransitive preference can also be compared with transitive preferences (i.e. intransitive forms 7 and 8 compared with transitive forms 5 and 6). This measure indicates the extent of intransitive behavior when premise relations make intransitivity possible. From this

perspective, also, intransitive responses are given more than would be expected overall ($P<.001$). Separate comparisons at each age indicate that the intransitive inclination is significant for age groups one ($P<.001$) and two ($P<.001$), but not for three ($.50<P<.70$). The age difference is significant ($P<.001$).

In this comparison of intransitive third-choice response when intransitivity is possible, there appears another indication of the difference between types of intransitive response. Though there were generally more intransitive than transitive preference responses by children, this difference is totally attributable to the prevalence of form 7 intransitivities, since in no group was there significantly more than one half form 8 intransitive response.

The results just reported concern the relation between age, shifting of response, and resolution of shifting in third-choice transitive behavior. This relation is shown in Table 9 and in Figure 1b. The eldest group of children provided transitive responses when intransitive responses were possible more frequently than did the younger groups ($P<.001$). The two younger groups were not detected to be significantly different ($.50<P<.70$). In general, the eldest group is no more likely than the younger groups to avoid the possibility of intransitivity by a non-shifting response. The comparison of response forms 1-4 (non-shifting) with 5-8 (shifting) for the three ages did not reach significance ($.20<P<.30$), nor did tests of these response differences for the two younger groups combined, as opposed to the eldest group ($.70<P<.80$), nor for the youngest group compared with the eldest group ($.30<P<.50$). However, shifting responses are of two

types, and the decreased tendency toward intransitive response in older children can be attributed partly to their lower inclination to give shifting responses of the form $x>y$, $x<z$ (.73 for age three as opposed to .85 for the younger groups, $P<.05$), as well as to a considerably greater tendency in these elder children to respond transitively after having made that shift (.51 for age three as opposed to .24 for the younger groups combined, $P<.001$).

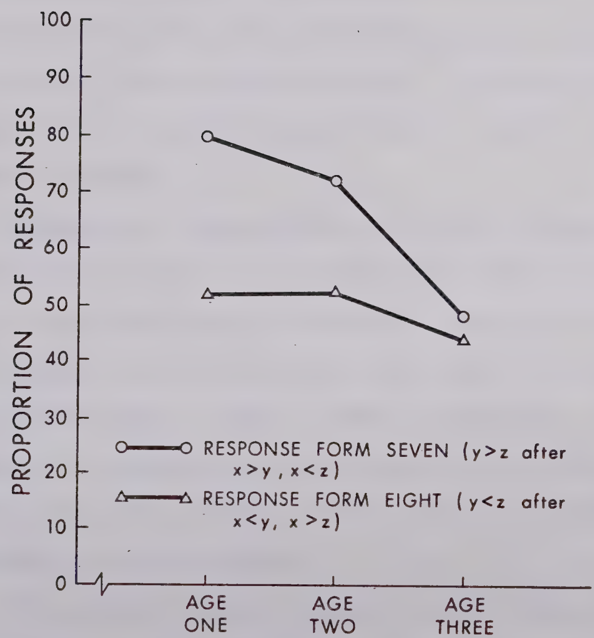
Age differences do not reach significance for shifting responses of the other sort (i.e. $x<y$, $x>z$, $.10<P<.20$). And on the basis of a Chi Square comparison of response forms 6 and 8 for age group three, as opposed to the younger groups combined, it cannot be concluded that elder children respond more transitively once in the $x<y$, $x>z$ shift situation ($.30<P<.50$). Figure 3 shows this relationship between age and form of intransitive response.

Separate comparisons of the six stimulus orders and of the four pair orders for the eight response forms did not indicate significant differences ($.75<P<.90$ for stimulus orders; $.30<P<.50$ for pair orders). Comparison of sex for the eight response forms was also not significant ($.90<P<1.0$). Overall comparison of age for the eight response forms indicated significant differences ($P<.001$).

Overall, consistent left-right positional responses do not appear in the data provided by the 720 subjects in the main portion of the experiment. Several isolated differences were found. Fifty-eight percent of the children of the youngest age group preferred the left hand color in the first pair ($P<.05$). Sixty-six percent of the children of this same age group who preferred the right hand color in

Figure 3

From the preference responses by children of three ages for all paired comparisons of three colors, the proportions of occurrence of the two forms of intransitive third choice when the first two choices made intransitivity possible. Median ages: Group one, 6;10, Group two, 8;11, Group three, 10;11. For each age group, n=240.



the first pair, and the left hand color in the second pair, preferred the right hand color in the third pair ($P<.05$). A comparable percent (i.e. 65%) of these youngest subjects who preferred the right hand color in the first two pairs, preferred the right hand color in the third pair ($P<.05$). Also, of children in the middle age group who preferred the left hand color in the first pair, and the right hand color in the second pair, 69% preferred the left hand color in the third pair ($P<.01$).

A further control question concerns the relative preferability of the three colors used (e.g. overall, is red preferred to blue, is red preferred to green, is blue preferred to green?). This is an issue since any disparity in the preferability of the items used would serve to decrease intransitivity of response. Separate comparisons of first-pair responses to the three combinations of colors indicated no significant differences.

Discussion: The psychological model of preference behavior. The issue of this research is a contention that either the act of choosing or some other aspect of confronting things in the choice situation changes the preferability of these things. To illustrate this we must ask what we attempt to learn by testing the subject's preferences. The preference we learn about from our measure should presumably be of longer standing than the duration of the question. It is assumed to be dispositional.

For example, if we ask a subject to rank blue, green and red from most-liked to least-liked, the ranking should presumably represent a disposition which both predates the question and survives after

it for some time. Assume that this subject gave us the ranking 1st blue, 2nd green, 3rd red. Surely we did not intend to create the particular rank given by the nature of the task. Presumably it indicates a state in the subject which exists apart from the task. However, in the three-choice problem used in this study, it must be concluded that the subject's preference responses, and hence their consistency, reasonableness, or whatever, are largely determined by conditions which operate quite independently of the subject's preference states. To demonstrate this let us return to the subject with the blue, green, red preference ranking of the colors and take him as the general case for the moment.

The choices given should represent inclinations present before the choices were made. Bearing in mind that blue, green and red have been applied in all possible ways to the pair forms xy, xz, yz, how does y come to be preferred most of the time by the eldest group (.68) after x has been preferred to both y and z? No relation between y and z has been established by the subject's having liked x better than both of them. For our subject with the blue-green-red ranking, y would presumably be preferred in this situation if x were blue, y were green, and z were red. But y was as often red as it was green in the study, so it should have been the non-preferred color half the time. How did red move ahead of green in the forty-five seconds or so it took the subject to respond to the choices? Red has benefited from some process involved in the choice situation, and the process is in harmony neither with the stability of the subject's dispositional scale of preferences, nor with the assumptions of logic.

Several results in addition to the one just cited require a unified explanation. They are best seen in the data of Table 6. First, there is the tendency for the subject not to prefer the color repeated in the second pair. In a sense, the cards are stacked in favor of the color, whatever it is, that appears in the z position. It was chosen by 77% of the subjects in this study on its first appearance. However, this does not indicate that the popularity of this color will last. In fact, it was preferred over y in the last choice less than half the time (i.e. .41 overall, $P<.001$). Chi Square results for the yz choice in the last pair for the three ages are: Age 1, $P<.001$; Age 2, $P<.001$; Age 3, $.10<P<.20$. No significant age effect was indicated ($.10<P<.20$).

Other results requiring explanation are the already mentioned preferability of y in the last choice (.59), and, more particularly, the strong tendency of the children to prefer the intransitive y after $x>y$ and $x<z$ ($P<.001$). In this last case, there is also an age difference ($P<.001$), making elder children less inclined toward the response.

The data strongly suggest that novelty exerts a controlling influence on preference behavior in children. Considering novelty as including both a tendency to respond in a new way and a tendency to respond to a stimulus not previously seen (or one seen less recently than another), allows for an influence attributable to the choices, themselves, and to the way in which the items to be chosen are encountered in the choice situation. For the tasks reported here, this would involve both new color and new response influences operating

differently at each step in the choice sequence. Based on these hypothesized influences, relative biased (i.e. non-logical) expectations can be made for the various response forms, and these expectations can be compared to the data.

From the perspective of novelty, we might expect the subject most often to prefer both a color not seen before (or not seen as recently as the other) and a color not preferred before (or not preferred as recently as the other). This expectation says nothing of the relative strength of the two influences.

The second choices by subjects in this study strongly support the new color/new response explanation. Color z, the new color, was almost always chosen. It was, however, not chosen so frequently when it was compared with a color which had not been chosen (i.e. $x<z$ after $x<y$) as when its opponent had just been chosen (i.e. $x<z$ after $x>y$). This difference is significant ($P<.01$) for the age groups combined (i.e. response forms 5+7 and 1+3 compared with 2+4 and 6+8). Comparisons made at each age separately indicated significance only for the youngest age group ($P<.01$). This supports recognition of a new response tendency as well as a stronger new stimulus tendency.

If the influences of novelty of stimulus plus novelty of response combine to sway choice in the second pair, where x and z should be preferred equally often, the extent of the departure of response from the .50/.50 expectation in each case might be taken as a measure of the strength of these influences. In the choice $x<z$ following $x>y$, both factors operate together to give the following proportions in excess of .50: age one, .35; age two, .35; age three,

.23. No indication of the relative influence of the two factors is given by these data alone. On the other hand, in the choice $x<z$ after $x<y$, the choice for the new stimulus, z, is the same, but x should have the influence in favor of a new response operating in its favor, and against z. Here, the proportions of response $x<z$ in excess of .50 for the three ages are as follows: age one, .18; age two, .28; age three, .19. These figures should represent the strength of the *new stimulus* influence when opposed by the *new response* influence at each age. The difference between these two sets of measures should give some indication of the strength of the *new response* influence alone: age one, .17; age two, .07; age three, .04. These comparisons are shown in Table 10. Some caution is required here since the comparison between *new response* features of $x>y$, $x<z$ and those of $x<y$, $x>z$ assumes that the *new response* influence to pick x in the second choice after having not picked it in the first choice is the same as the influence not to pick x in the second choice after having picked it in the first choice. There is no reason to believe these are the same.

Taking the difference figures as representative of the relative *novel stimulus* and *novel response* influences on preference behavior at the three ages tested, several tentative conclusions are possible. It appears that generally *new stimulus* influences are stronger than *new response* influences. Both influences seem to decrease with age. However, the data on which these observations are based involve only the first two choices, in which transitivity is not directly at issue.

The most interesting results appear in the third choices, in which the presence of transitive constraint sometimes conflicts with

Table 10

The strength of new stimulus and new response influences on the preference behavior of children of three ages as measured by the difference from a .50 expectation in proportions of subjects responding $x<z$ after having responded either $x>y$ or $x<y$. Median ages: Group one, 6;10, Group two, 8;11, Group three, 10;11.

	new stimulus and new response influences together (first choice $x>y$; second choice $x<z$)	new stimulus influences opposed by new response influences (first choice $x<y$; second choice $x<z$)	difference
Age group one	.35	.18	.17
Age group two	.35	.28	.07
Age group three	.23	.19	.04

novelty. Based solely on considerations of novelty, forgetting transitivity for the moment, we can build an alogical model that provides at least a direction for final choice response proportions. Highest frequency of response might be expected for $y>z$ after $x>y$, $x<z$, since in that final choice, y is the newer color (not having been seen since the first pair), it is a color not chosen before, and it is compared with a color just chosen. All hypothesized novelty influences favor choice of y here. There was a higher proportion of response to y in this option than in any other (.67 overall, .80 for the youngest group).

High response frequency might also be expected for $y>z$ after $x>y$, $x>z$ since y again appears as the newer color, and it has not been chosen before. However, this time it appears with a color which also has not been chosen before, but which is not new, having just appeared. The novelty influences are in some opposition here. Though high, proportion of response to y here should perhaps be not so high as in the first case. The data are consistent with this (.59 overall, .53 for the youngest group).

These factors of stimulus novelty and lack of previous selection combine to account neatly for the high frequency of preference for y in the two choices that follow $x>y$, $x>z$ and $x>y$, $x<z$. In both cases, y is relatively new and has not previously been chosen when it appears in the third pair.

So far as novelty is concerned, the color y in the last pair is in somewhat the same position as z in the second pair, but with less advantage. Color z is totally new in its second-pair appearance,

while y has appeared before when it appears in the third pair. The data are consistent with this view. Also, in one half of the third choices, there are novelty influences which work directly against selection of y. In the two choices that follow $x<y$, $x>z$ and $x<y$, $x<z$, y is the newer color, but it has been previously selected. The two hypothesized novelty effects should oppose one another in these two situations, and proportions of selection of y should be lower. In fact, y was chosen just about half the time (.53) in these two choices, compared to its .63 selection in the other two.

In the third choice that follows $x<y$, $x<z$, y is the newer color of two which have both been selected previously. Here it was selected .54 of the time. In the choice that follows $x<y$, $x>z$, y is the newer color, but it has been selected before and is compared with a color which has not been selected before. Here its proportion of selection was .51. These data as well as the combinations of alleged influences on third choice behavior are shown in Table 11.

A general novelty interpretation, including both <u>novel response</u> and <u>novel stimulus</u> elements, fits the data fairly well. It explains why so many more subjects give form 7 than form 8 intransitive responses. In the choice that leads to form 7 response, the subject finds color y (the intransitive choice) in a particularly strong position from the novelty perspective. It is the newer color, it has not been selected before, and it is shown with a color which is not new and which was just chosen. In the choice that leads to form 8 response, the subject sees color z (the intransitive choice) with novelty working against it. Here z is compared with y, which is

Table 11

Hypothesized influences of novelty and logic on the third-choice preferences of children of three ages responding to all paired comparisons of three colors. Median ages: Group one, 6;10, Group two, 8;11, Group three, 10;11. Also shown are proportions of responses by adult subjects in a similar task. For each age group of children, n=240. Adult group n=84. All responses are shown as choice of color y in the last of three pairs presented: xy, xz, yz. Data relevant to this table are shown in another form in Table 6.

Influences favoring selection of y in the last choice; present (+) or absent (-)	choice $x>y, x>z, y>z$	choice $x>y, x<z, y>z$	choice $x<y, x>z, y>z$	choice $x<y, x<z, y>z$
y newest color	+	+	+	+
y not previously chosen	+	+	-	-
y paired with a color previously chosen	-	+	-	+
Transitive restraint	absent	choice in conflict	choice in agreement	absent
Proportions of responses				
Age group one	.53	.80	.48	.53
Age group two	.56	.73	.48	.56
Age group three	.67	.48	.56	.54
(Adult group)	(.74)	(.25)	(.67)	(.36)

the newer color and which, thereby, puts the primary novelty influence in support of transitive response. Novelty can also explain why there is so much more *shifting* of one type ($x>y$, $x<z$) than of the other ($x<y$, $x>z$). To *shift* to x after not having preferred it, the subject must violate the principle of new stimulus selection, but for the other *shift*, all novelty factors are favorable.

Under this novelty interpretation, we can see age differences in the data as attributable to elder children's reduced dependency on novelty in preference response when novelty is in conflict with logic. The eldest group was not so inclined as were the younger groups combined to respond to the novel, though intransitive, color y after $x>y$, $x<z$.

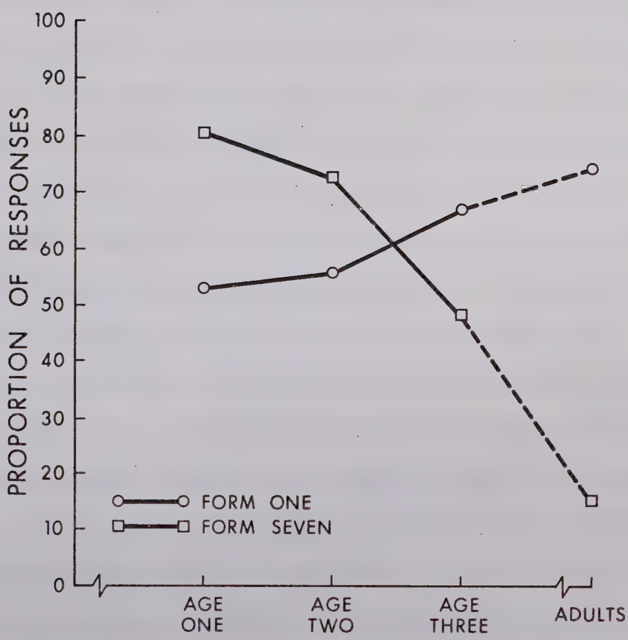
Children of the elder two groups should have been well in control of transitive inference abilities regardless of which diagnostic criteria are favored. A generalization of the logical rule of transitive inference from physical object operations to subjective preference, rather than a reduced dependency on novelty, as such, could account for the elder children's decreased intransitive response. It could be that the tendency to respond to the novel situation still exists in these subjects, and is in conflict with their emerging, generalized rational-logical rule capabilities. Consistent with this observation a substantial number of such subjects do respond intransitively to color y in the last pair in spite of logic. Their proportion of y responses (.49) is prominent, even though considerably less than the youngest subjects' (.79) strong inclination to color y in this situation. Two main problems posed by such results as these

are the strong intransitive bias of the young children and the substantial, though decreased, instance of intransitive response given by subjects who are clearly in command of the transitive inference. A novelty criterion in preference can account for these results. This view of the eldest group's ambivalence of preference response (i.e. still inclined toward illogical, novel responses, but largely dissuaded from then) is supported by the high proportion of their responses to the novel stimulus in the case where novel responding does not conflict with logic. After $x>y$ and $x>z$, .68 of the eldest subjects chose y. It would seem that the elder child, in relinquishing his novelty inclinations to the demands of logic, compensates by indulging in a stronger than usual novelty response where logic is not at issue. It is interesting to notice that, at least in rank order, the logical decrease in form 7 responses with age corresponds to an increase in form 1 responses. A Chi Square test indicated this interaction as significant ($P<.05$). The response relation between age, novelty, and logical constraint is shown in Figure 4.

In general, then, it is perhaps not the case that novelty as an element in preference behavior decreases with age. It seems to decrease in cases where it comes in conflict with the demands of inference. But in other situations in plays a prominent role. The preference behavior of cognitively developing children seems to be influenced by factors in tension. It is the relation of these factors and the give-and-take between them that explains the patterns of children's preferences.

Figure 4

The relation between age and novelty responses which are and are not in conflict with logical expectation. Shown are proportions of response for y over z following x>y, x>z (form one) and following x>y, x<z (form seven) by children of three ages and an adult group. Form seven response is a novelty response in conflict with logic (i.e. it is intransitive). Form one response is a novelty response not in conflict with logic (i.e. transitivity is not at issue). Median ages: Group one, 6;10, Group two, 8;11, Group three, 10;11 (n=240 for each age). Adults were university undergraduates (n=84).



Preference-inference conditions. Tables 12 and 13 show the results of a separate experimental condition in which subjects, who were not used in any other part of the experiment, were shown two enlarged response sheets marked so as to indicate Red>Green and Red<Blue, were told that the demonstration represented the preferences of another class of comparable age, and were asked to pick the other class's choice between green and blue. Table 12 presents data drawn from all three age levels tested in the main part of the experiment. Table 13 is concerned mainly with verbal explanations given for transitive choices by a different group of children of the youngest age level tested.

It was thought that this measure would provide some indication of the extent to which transitive inference for preferences is operative at each age tested. A transitive response proportion of .50 would represent a chance level of occurrence and the absence of logical influence. It was thought that the younger subjects would not show appreciable transitive inference for preferences and that the elder subjects would show the increase expected of children who are at an age several years beyond that at which even the Genevan diagnostic criteria are satisfied for such operations as transitive inference for length. Data for the middle and eldest groups fit this expectation. Forty-five percent of the middle age group indicated the transitive choice for the alleged other class. Sixty-two percent of the eldest group gave the transitive response. However, the youngest group is unaccountably high in transitive response. Seventy-one percent of these children indicated the transitive choice for the other class. It was in the light of this result that twenty-two children of this age were individually given

Table 12

Preference-inference condition. Transitive and intransitive choices by children of three ages shown demonstration cards indicating red> green and red<blue, told that the demonstration represented the preferences of another class of comparable age, and asked to pick the other class's choice between blue and green. Response data is shown according to the division of subjects by age level, sex, and the left or right position of the transitive color (i.e. blue) on the answer sheet. Median ages: Group one, 7;0, Group two, 9;2, Group three, 11;2.

		position of transitive color on response sheet	frequency transitive	frequency intransi-tive	% transitive
Age level one (n=42)	Males (n=26)	Left (n=11)	9	2	
		Right (n=15)	11	4	
	Females (n=16)	Left (n=10)	6	4	
		Right (n=6)	4	2	
		Totals........	30	12	71
Age level two (n=74)	Males (n=35)	Left (n=15)	9	6	
		Right (n=20)	8	12	
	Females (n=39)	Left (n=21)	7	14	
		Right (n=18)	9	9	
		Totals........	33	41	45
Age level three (n=52)	Males (n=21)	Left (n=10)	6	4	
		Right (n=11)	8	3	
	Females (n=31)	Left (n=15)	9	6	
		Right (n=16)	9	7	
		Totals........	32	20	62

Table 13

Preference-inference condition with verbal explanations. Transitive (t) and intransitive (c) choices by 22 children individually shown demonstration cards indicating red>green and red<blue, told that the demonstration represented the preferences of a class of comparable age, and asked to pick the other class's choice between blue and green. Also shown are the verbal explanations of some subjects for their judgments of the other class's preference as well as each subject's personal preference between the blue-green samples. Median age: 7;0.

Subject	Sex	Age	Transitive or cyclic response	Personal preference	Explanations nontransitive hypotheses indicated by *
1	m	7;5	c	G	-
2	m	7;3	c	G	-
3	m	6;11	t	B	"Because it's prettier than green."
4	m	6;10	t	B	"Because it has an X under it."*
5	m	7;0	c	B	"Don't know."
6	m	6;10	c	G	"Because it's pretty."
7	m	7;0	t	B	"Because it's the favorite." (answered only when pressed)
8	m	7;4	t	B	"Because it had a mark." (questioned, indicated reference to Red-Blue card)*
9	m	7;9	c	B	-
10	m	8;3	c	G	-
11	m	6;9	t	B	(hesitated, gestured toward the Red-Green card, then said he didn't know; questioned, said the demonstration cards didn't contribute to the answer.)
12	m	7;8	c	B	-
13	m	7;1	t	B	(could give no explanation)
14	m	6;10	c	G	-

Table 13 continued

Subject	Sex	Age	Transitive or cyclic response	Personal preference	Explanations nontransitive hypotheses indicated by *
15	f	6;6	t	B	"Because sometimes green looks nice and sometimes it looks awful."
16	f	7;0	c	G	(could give no explanation)
17	f	6;11	t	G	(could give no explanation)
18	f	7;5	c	B	-
19	f	6;8	t	B	"Because it's pretty."
20	f	6;10	t	B	(could give no explanation; said the demonstration cards didn't contribute to the answer)
21	f	7;6	t	G	"Because it was second." (questioned, indicated reference to the Red-Blue card)*
22	f	7;2	c	B	-

Proportion giving transitive response	.50
Proportion who preferred the color they had reported as the other class's preference	.68
Proportion who preferred the color they had reported as the other class's preference when that choice was transitive	.82
Proportion who preferred the color they had reported as the other class's preference when that choice was intransitive	.55
Proportion of transitive responses supported by apparent egocentric explanations	.27
Proportion of transitive responses supported by explanations indicating nontransitive hypotheses	.27
Proportion of transitive responses supported by transitive explanations	.00
Proportion of transitive responses supported by other explanations or by no explanation	.46

the inference-preference problem with verbal explanations requested for all transitive and some intransitive responses. Data for this condition are given in Table 13. Since only 50% of these subjects gave the transitive response, a proportion much more in keeping with expectation, I am inclined to dismiss the high 71% rate of transitive choice by their age-mates as unreliable.

The data provided by the subjects' explanations of their responses require discussion apart from their bearing on the relative level of transitive response.

The experimental procedure followed here was quite close to that reported by Smedslund (1960) for the study of preference, and the data reflect on the issue of nontransitive hypotheses raised by Smedslund (1963b). According to Smedslund's (1960) analysis, a predominantly intransitive response bias in his pre-school subjects was attributable to their egocentrism (i.e. they missed the relevance of demonstrations of A>B and A<C for comparison B?C because they tended to evaluate the BC relation in terms of their own preferences. The subjects who were asked to pick the other class's preference between green and blue and were asked to give explanations for their decisions were also asked to indicate their personal preference between green and blue after the other measures had been taken. One way of revealing the alleged egocentrism effect on transitivity of inference would be through a relation between the color the child attributes to the other class, his own personal preference, and his explanations. Of the explanations offered by transitive subjects for this task, three, or 27%, are clearly egocentric. These are the explanations given by

subjects number three, fifteen, and nineteen, listed in Table 13. Subject number nineteen, for example, explained that she thought the other class preferred blue to green "because it's pretty". Some of the intransitive responses were also clearly egocentric. For example, subject number six said he thought the other class preferred green to blue "because it's pretty".

The .68 proportion of subjects who picked as their personal preference the color they had previously indicated as the other class's choice would seem at first glance to offer support for an egocentric effect on inference. However, the relation between inference and preference need not be one way. The transitive relation could influence the child's personal preference rather than the other way around. The .68 figure, representing subjects who gave the same response for the other class's and for their own preferences, is composed of two quite different relations. Eighty-two percent of the children shared the preference of the other class when the other class had been given the transitive choice, while only fifty-five percent did this when the intransitive choice was involved. From considerations of egocentrism, we would expect these two figures to be the same unless either the green or the blue were preferable to the children in and of itself. This is an issue since in the inference-preference condition under discussion, blue was always the transitive choice and green was always the intransitive choice. In the main part of the experiment, when green and blue appeared in the first pair of the three test pairs, blue was preferred by 53% of the 240 subjects of the youngest age group, which is not a significant result. So, there is not apparently a general preference

bias for green or blue. These data are available in Appendix C with reference to Tables 1 and 4.

Egocentrism would maintain that a high proportion of subjects would make the personal choice of the color green after attributing it intransitively to the other class since selection of that color for the other class was supposedly based on the personal perspective. This seems not to be the case. The high frequency (i.e. 88%) with which subjects followed the other class's transitive choice with their own personal choice implies, on the other hand, that some aspect of the relation of the colors in the demonstration cards substantially determined personal preference. This influence could be the transitive relation. It could be the factor behind Smedslund's (1963b) nontransitive hypotheses. Explanations offered by three of these subjects (i.e. 27%) for transitive responses were clear examples of the same nontransitive hypothesis: B<C because A<C.

Adult preference patterns. Some of the developmental inclinations discussed in this report, particularly the place of novelty in the child's preference priorities, are supported by comparison with the preference responses of adult subjects. Table 6 includes the distributions of choices by an adult sample in a task similar to that performed by the children in the present study. The results are taken from a previous research project conducted by the writer (Bradbury, 1970). Comparison of these data with the results of the present study is limited by several differences in experimental treatment. For example, the colors were not the same as those used with the children, and the colors in pairs were presented to the adults in succession rather than

simultaneously. Details of the experimental treatment of the adult groups are given with the basic data in Appendix E. In spite of the differences between experimental treatments of the children and the adults, similarities are sufficiently strong to justify some comparison.

Considering second-choice behavior, it was observed that *shifting* responses, while not inconsistent, were in the service of intransitivity since it is only after such responses that an intransitivity can occur. It was hypothesized that the elder children's expected decrease in intransitive behavior would be partly attributable to a decline in *shifting* responses. Though this hypothesis was not supported overall, the eldest group of children did less frequently give *shifting* responses of the type x>y, x<z (.73 as opposed to .85 for younger groups). The adult group gave this form of response only about as often as was expected logically (.51). This response is a novelty response which is indirectly in opposition to the consistency of preference. Adults provide this response much less than children, and by about eleven years of age, children are moving in the adult direction. Though the decline in intransitive preference behavior is, as hypothesized, detectable in the age range of the present study, the decline in intransitive-related *shifting* behavior is not complete by eleven. It is perhaps not fully acquired until adolescent years. It lags behind the decrease in intransitive preference, a decrease which is largely accomplished by a discriminative resistance to novel stimulus influences.

For third-choice behavior, the clearest novelty-induced intransitivity is form 7 response. Here the eldest group has dropped

to .49 from the combined younger groups' .76 proportion of response. The adults' proportion of form 7 responses was .25. The eldest children tested are roughly in between earlier childhood and adult patterns of preference response. The novelty inducements to intransitive preference response explain the lag of preference consistency behind mastery of the transitive inference.

The adult data also offer implications for the observation that a compensatory increase in response to novelty, where such responding does not violate logic, seems to follow a decline in logic-conflict novelty responding. Form 1 responding is novelty responding not in conflict with logic. Form 7 responding is novelty responding in conflict with logic. The eldest school age group tested gave .68 form 1 responses as compared to the younger groups' average proportion of .55. The adult subjects provide form 1 responses .74 of the time when faced with the choice between forms 1 and 3. The relation of these two response tendencies is shown in Figure 4. These proportions refer to last choice selections of y over z.

The rather high adult frequency of novelty responding not in conflict with logic, paralleling a low frequency of such behavior when it is intransitive, is also supported by comparison of adult and child responses to the second choice. As already discussed, adult data followed the trend established by the eldest children's decline in $x>y$, $x<y$ *shifting* behavior. This form of response could be described as a novelty response indirectly in conflict with consistency. The other second-choice novelty response, $x<y$, $x<z$, is not in conflict with logic. Here the proportion of adult responses was high (.73), though in this case no higher than that of children's responses (.72).

It appears that human preference behavior in the early school years is substantially controlled by responses to novel aspects in the choice context, and that this priority of response operates in disregard of implied logical relations between choices. Several years after the child masters the transitive inference, his preference priorities for novelty seem to be placed under stress in the situations in which novelty opposes implied logical consistency. This stress seems to accomplish a decrease in such preferences, showing its effect earliest in the third-choice preferences, where the transitive relation is in direct question. Later it appears to influence second-choice preferences, where <u>shifting</u> indirectly places consistency in jeopardy.

The child's preference behavior is suspended between two sets of criteria, and is in a process of movement from one to the other. The movement's end point, as tentatively established by adult data, is about one half attained in the pre-adolescent, eldest group of children tested. But even at its end point of adult development, preference behavior is shown to be far from completely in conformity with transitive demands. Some of the .11 proportion of adult preference responses which were intransitive might perhaps be attributed to the influences which contribute, in decreasing strength, to the intransitivity of children's preferences. Some adult preference intransitivity is perhaps attributable to a residue of influence from earlier, novelty criteria. This suggestion is made more plausible by the high instance of novelty responding in adult behavior where transitivity is not at issue.

Summary and Conclusions

The developmental end point of the logical consistency of preference is fairly well known because of the interest taken in the topic by choice theorists. This adult state provides predominant transitivity with a small though notable instance of intransitive choice. The adult data reported here contained 11% intransitive choices, which is something less than one-half the chance expectation. Both this tendency toward transitivity and the failure to reach it completely are of theoretical importance. The transitive bias, consistent with the classical model of the rational man, gives evidence of the empirical foundation of logical rules in behavior. The failures have been used to construct various models incorporating stochastic influences in the choice context. The data reported here suggest that novelty factors be added to the contextual model of choice behavior.

The primal state of the child's preference, from which development takes place, is not nearly so well known as the end point of adult choice organization. The data reported here offer indications of the principal factors exerting influence on preference at several points in the progress of logical development. It is clear that transitive preference lags several years behind transitive inference in development, and partly because of this, the present data are not in a good position to offer an indication of the more primitive state of the child's preference priorities. Though the three ages tested are well suited to observations of transitive preference development, they represent children who are fairly far along in the process of logical

development. No pre-school children were tested. It seems safe to say that the youngest group tested (i.e. about seven years of age) was well in control of some form of functional transitive operation, even if it was perhaps not sufficiently well established or articulated to satisfy Genevan diagnostics.

Nevertheless, the data do point toward increased intransitive preferences at younger ages. Smedslund's (1960) data support this supposition. How far the curve of Figure 2 might go in the intransitive direction is an open question answerable only by testing at younger ages.

The response strategy or preference priority that accounts for this intransitive inclination is well indicated in the available data. Children prefer things which are new and/or which they have not preferred before. In their preferences they seem to be sampling as widely or completely as possible from the universe of available things and events (i.e. objects and choices), and unlike the adult inclination, one choice from a child does not indicate a later loyalty. Before the novelty priority is perceived as being in occasional conflict with logical implications, that is, at an age when the novel aspects of the environment are clearly discriminable and the logical-relational implications in the environment are not, the child maximizes this wide sampling from the available universe of things and events. For the youngest group tested, response was 85% in this direction. However, these children were about seven years old, and it is difficult to say how far above 85% this response inclination might go in testing younger children.

There is some indication that the novelty of response as a strategy is deliberate even in pre-school children. One positive feature of the Genevan practise of demanding verbal explanation of response is that these explanations are frequently reported in the literature and offer material for interpretations other than those first made. As support for his contention that the pre-school child's intransitivity indicates an egocentrism characterized by a concrete and perception-bound attitude, Smedslund (1960) printed the following verbal explanations, all of which support a novel response rationale: "'She will have the blue car. Why? Because she hasn't had that one before.' 'He will choose the rabbit; if not he will get two teddy bears.' 'He has not chosen that one before.' 'She has not preferred the doll before.' 'Because it was last again.'" To Smedslund this indicates a perceptual, pre-operational strategy which is Gestalt in nature. The child is seen as motivated by considerations of good form or closure (i.e. choosing all items, seeing that items are balanced in terms of response relations). This Gestalt balance interpretation of the pre-logical child's motivation takes rather a different perspective than the novel stimulus/novel response view offered earlier in this paper, however, the two positions lead to much the same behavioral predictions.

It is interesting to note that the intransitive or cyclic relation is the only organizational structure in which the items are held in a balance that denies the hierarchial pattern required for an ordinal scale. The intransitive relation makes A greater than B greater than C greater than A in an indefinite, closed cycle. But,

once again, the point is raised that intransitivity can take two forms. Form 7 and form 8 responses are quite the same in terms of the cyclic quality of intransitivity, and if the Gestalt motivational explanation were self-sufficient, they should be equally prevelant. Yet one occurs much more frequently than the other. The child's most primitive organization of preference must be more complex than previously suspected.

Footnotes

1. Here, the symbols < and > will be used to indicate "is preferred to". Thus, R>B means red is preferred to blue.
2. The term *personal preference* is used here to indicate the sort of response asked for in this study (i.e. choice of the thing "liked best"), which is more of an aesthetic response than the behaviors studied in the literature on preference (e.g. Coombs, Tversky), which in addition include judgments of more obvious utility, such as gambling choices, and perceptual judgements, such as the comparability of colors on some objectively definable scale.
3. In addition to the forms already mentioned, A>B, B>C, A>C and A=B, B=C, A=C, transitivity includes A=B, B>C, A>C and A>B, B=C, A>C. The first of these additional forms was proposed by Youniss and Murray (1970) as a control for the nontransitive hypotheses suggested by Smedslund (1963b). It has been used in developmental studies of inference instead of the form A>B, B>C, A>C because it eliminates the conclusion A>B therefore A>C (Murray and Youniss, 1968; Brainerd, 1972). It does not, however, eliminate the possibility of the analogous conclusion C<B therefore C<A.
4. Smedslund's (1960) diagnostic criterion is not clear. He states the condition as "All four predictions correct *and/or* at least one partial explanation". (The italics are in the original.) It is not clear what is meant by "and/or". In practise it seems to have meant all four predictions correct and at least one explanation, which could be either complete or partial.

5. There is another ambiguity in Smedslund's (1960) report. He reports that seven response patterns were "non-transitive", and he gives $A>B$, $A<C$, $B>C$ as an example. It is reasonable to add to this the formally comparable pattern $A<B$, $A>C$, $B<C$, and conclude that seven of the sixteen response sets obtained were distributed over these two patterns. Smedslund reports that nine response patterns were "transitive", and he gives $A>B$, $A<C$, $B<C$ as an example. To the example given, it is obvious that the formally comparable pattern $A<B$, $A>C$, $B>C$ should be added. However, it must be inferred that Smedslund includes the transitively indeterminate patterns such as $A>B$, $A>C$, $B>C$ in his "transitive" category. The reasonable conclusion, therefore, is that seven of the response sets obtained were distributed over the two intransitive patterns, and the other nine sets were distributed over all other possible patterns.
6. The stimuli used by Smedslund (1960) in his study of the personal preferences of pre-school children were illustrations of a red, a green, and a blue toy car.
7. The experimenter is grateful to the Edmonton Public Schools and to the personnel of the individual schools involved for providing subjects for this study.
8. The word *reject* is used here casually to avoid awkward repetitions of *not preferred*. Rejection of the color not preferred is only indirect.
9. The thesis was typed by Linda Hawreliak. The job of writing was made much easier by the efficiency of her help and by her cooperative attitude in a task that was certainly trying at times.

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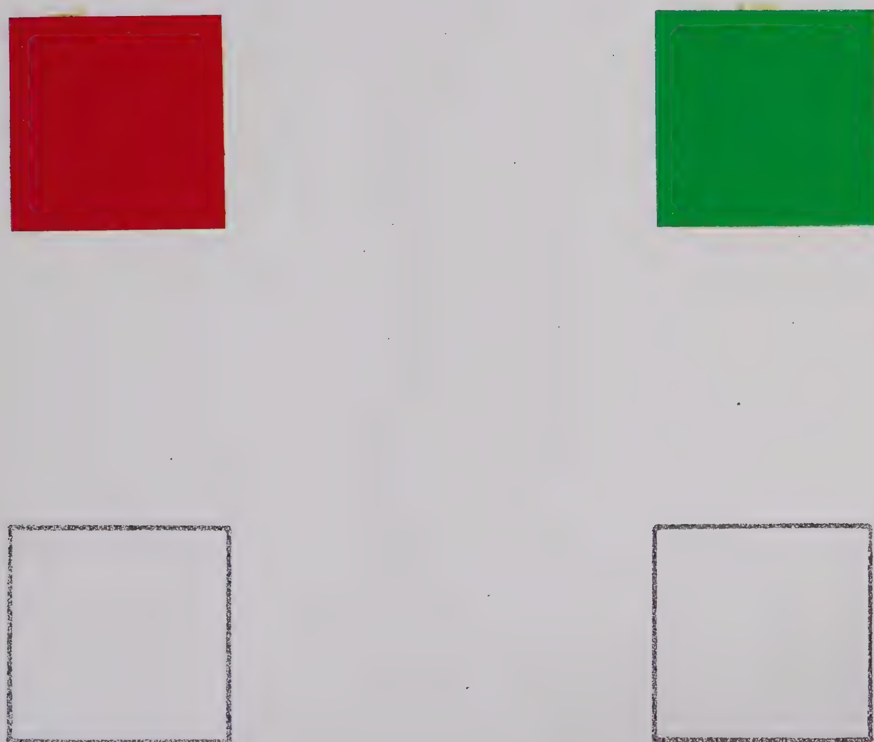
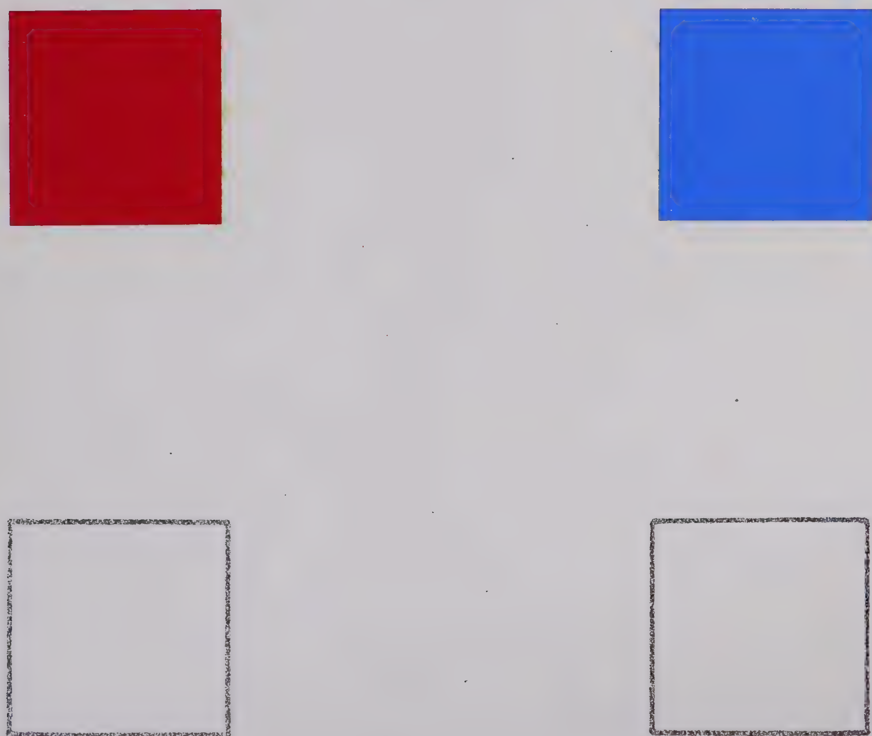
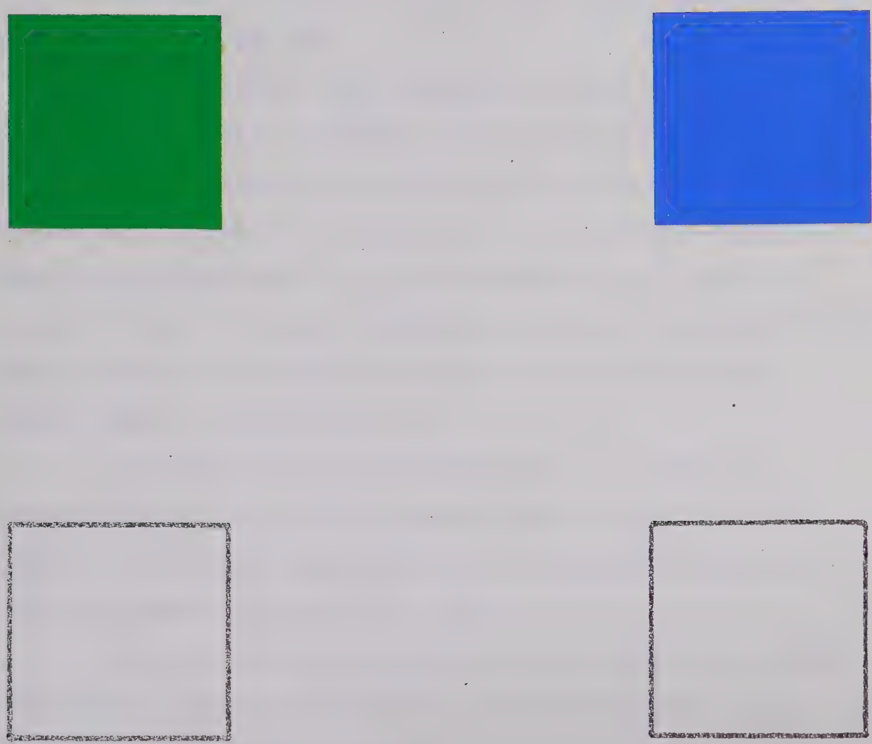
Appendix A

The following four pages give a sample of the booklets used in the study of the patterns of children's preferences. The order of presentation of the stimuli in this sample is Order 1-2 of Table 4 of the text. It is one of 24 orders used.







Appendix B

This is to provide an answer to the position preference design problem in the study of the patterns of children's preference responses. All paired combinations of three colors, red, green, blue, were used in all six orders of the three colors. These details are given in Table 2 of the text.

The stimulus pairs were presented on successive pages of a booklet, as described in the Methods section of the text and illustrated in Appendix A. Instructions were given to the subject to mark the box beneath the preferred color on each page. In this procedure a positional response bias could have a considerable influence on the consistency of sets of choices. This footnote provides a description of the various forms of this possible influence and explains the control measures taken in the experiment.

Red, green and blue are represented by R, G, and B. For purposes of this discussion, only stimulus Order 1 of Table 2 is used, though it is understood that the principle illustrated below applies also to the other five orders of R, G, and B.

There are eight ways the color pairs R-G, R-B, G-B (or any of the other five applications of the three colors to that form) can be applied to the left-right variation:

	1	2	3	4	5	6	7	8
1st pair	RG	RG	RG	RG	GR	GR	GR	GR
2nd pair	RB	RB	BR	BR	RB	RB	BR	BR
3rd pair	BG	GB	GB	BG	GB	BG	BG	GB

A positional response bias would influence consistency of choice differently in these different orders of presentation. With Orders 1, 2, 7, 8, an entirely positional response (that is, one involving all three responses to the left or to the right) would produce consistency. This is also true of a partial positional response (that is, one involving two out of three responses to the left or to the right) so long as it appeared in the first two choices, since the subject would have thus avoided shifting, shifting being a prerequisite of intransitive response. Shifting is responding differently in the second choice to the color common to the first two pairs of the choice sequence (i.e. $x>y$, $x<z$ or $x<y$, $x>z$).

In some of the orders, however, a positional response would reduce consistency. With Order 6, for example, total positional response precludes transitivity and partial positional response involving the bias in the first two pairs places the subject in jeopardy of providing an intransitivity by requiring a shift.

Orders 6 and 7 have opposite relationships to the positional response-consistency question. These differences are illustrated below by showing the eight possible configurations of response to each of the two orders and the consequences of each of the eight configurations. (For details of the eight response configurations, see Table 1 of the text. These eight response configurations should not be confused with the eight left-right variations given above.)

Order 6, in which positional response hinders transitivity and the opposite of positional response facilitates transitivity. The numbers 1 through 8 refer to the eight possible forms of response to any

set of all paired comparisons of three items. The abbreviations t, n-t, c indicate transitive, nontransitive, and cyclic or intransitive:

	1	2	3	4	5	6	7	8
1st pair	(G)R	G(R)	(G)R	G(R)	(G)R	G(R)	(G)R	G(R)
2nd pair	(R)B	R(B)	(R)B	R(B)	R(B)	(R)B	R(B)	(R)B
3rd pair	(B)G	B(G)	B(G)	(B)G	(B)G	B(G)	B(G)	(B)G
positional response	total	total	partial	partial	partial	partial	partial	partial
positional response in first two pairs	yes	yes	yes	yes	no	no	no	no
consistency	c	c	t	t	n-t	n-t	n-t	n-t

Note that in configurations 1 and 2, as illustrated above, it is a positional response in the first two choices that makes intransitivity possible by producing a <u>shift</u>, and it is the continuation of this positional response in the third choice that makes the set intransitive. Note too that in configurations 3 and 4, it is a positional response that makes intransitivity possible by producing the <u>shift</u>, and it is the violation of this positional response in the third choice that makes the set transitive. Also, it is the violation of a positional response in configurations 5, 6, 7, 8 that makes nontransitive consistency inevitable by avoiding a <u>shift</u>. The last choice in each of these configurations can not be intransitive, so the partial positional responses established by these four third choices are irrelevant to the issue.

<u>Order 7</u>, in which a positional response facilitates consistency, and the opposite of positional response hinders consistency.

	1	2	3	4	5	6	7	8
1st pair	(G)R	G(R)	(G)R	G(R)	(G)R	G(R)	(G)R	G(R)
2nd pair	(B)R	B(R)	(B)R	B(R)	B(R)	(B)R	B(R)	(B)R
3rd pair	(B)G	B(G)	B(G)	(B)G	(B)G	B(G)	B(G)	(B)G
positional response	total	total	partial	partial	partial	partial	partial	partial
positional response in first two pairs	yes	yes	yes	yes	no	no	no	no
consistency	n-t	n-t	n-t	n-t	c	c	t	t

Note the opposition of results produced by the same forms of response as given to Order 6. In this case (Order 7) either total positional response or partial positional response shown in the first two choices guarantees consistency by avoiding a shift. Note also that it is the violation of a positional response in configurations 5, 6, 7, 8 that produces the shift, and that it is the establishment of a positional response with the immediately preceding choice that produces the transitive results in configurations 7 and 8.

Orders 2 and 3 stand in the same relation to each other as do Orders 6 and 7. Order 2 would facilitate consistency under influence of positional response, and Order 3 would hinder it.

Further, an overall bias for either left or right responding might influence consistency in ways not accounted for by a balancing of only Orders 6 and 7.

Contrasting Order 7 with Order 2, a right-side bias, to a greater extent than a left-side bias, in response to the first pair might be more easily perpetuated in the second choice by the appearance of the just-chosen color in the same, right-hand position of that

second pair. The subject's choosing a particular color in the first pair may incline him to choose that same color in the second pair to a greater or lesser extent than his not choosing a particular color in the first pair may incline him not to choose that same color in the second pair. This possibility was one of the issues of particular interest in the study. Orders 3 and 6 stand in comparably opposite relation to one another.

Orders 2 and 3 balance each other, as do Orders 6 and 7, on one level of possible positional response influence. Also, Orders 2 and 3 balance Orders 6 and 7 on the other level of possible influence.

The other four orders balance each other in comparable ways, Order 1 balancing Order 8 and Order 4 balancing Order 5. These Orders are not so interesting to the issue of the influence of positional response on consistency since in each of them a positional response bias would sometimes facilitate and sometimes hinder consistency. As shown above, in each of Orders 2, 3, 6, 7, a bias will always either hinder or facilitate transitivity.

A control for the positional response influence was achieved by running one-fourth of the subjects on each of forms 2, 3, 6, 7 at each age with sexes balanced. Positional response was, thus, required to decrease and increase consistency equally for all groups, and could not influence group differences.

Appendix C

The basic data on the preferences of 720 children for all paired comparisons of three colors. The responses are shown as distributed over their eight possible forms, which are described in Table 1. The balanced division of subjects according to sex, age, and the stimulus conditions described in Tables 2, 3, and 4 is also indicated. Five children of each sex for each of the three age groups were assigned to each of the twenty-four stimulus conditions. Under each condition, responses are entered as frequencies, with totals shown both as frequencies and as percents.

AGE 1

PAIR ORDERS

Pair order 2

STIMULUS ORDERS		1	2	3	4	5	6	7	8
1	M	1	1	1			1	1	
	F				2	1		2	
2	M				2		1	1	1
	F		2		1			1	1
3	M					1		3	1
	F		1			1		3	
4	M		1		2	1		1	
	F		1		2	1		1	
5	M		2					2	1
	F	1					2	2	
6	M		1	1		1		2	
	F		2		1			2	
ALL STIMULUS ORDERS	M	1	5	2	4	3	2	10	3
	F	1	6	0	6	3	2	11	1
M&F Freq.		2	11	2	10	6	4	21	4
%		3	18	3	17	10	7	35	7

Pair order 3

STIMULUS ORDERS		1	2	3	4	5	6	7	8
1	M		1			3		1	
	F				1	2	1	1	
2	M			2	1			2	
	F	1			2		1	1	
3	M		2		2	1			
	F		3		1			1	
4	M		1	1		1		2	
	F	1	1			1		2	
5	M	1	1		1		1	1	
	F	1	1				1	1	1
6	M	2	1		1			1	
	F			1				4	
ALL STIMULUS ORDERS	M	3	6	3	5	5	1	7	0
	F	3	5	1	4	3	3	10	1
M&F Freq.		6	11	4	9	8	4	17	1
%		10	18	7	15	13	7	28	2

Pair order 6

STIMULUS ORDERS		1	2	3	4	5	6	7	8
1	M		1		2			1	1
	F		1			1		2	1
2	M		1		1			2	1
	F		1		2			2	
3	M		1		2			1	1
	F		2		1				2
4	M		1		3		1		
	F				2	1		2	
5	M				1		1	3	
	F				1		1	2	1
6	M		1	1		1		2	
	F		1		1			3	
ALL STIMULUS ORDERS	M	0	5	1	9	1	2	9	3
	F	0	5	0	7	2	1	11	4
M&F Freq.		0	10	1	16	3	3	20	7
%		0	17	2	27	5	5	33	12

Pair order 7

STIMULUS ORDERS		1	2	3	4	5	6	7	8
1	M				1		2	1	1
	F				2			2	1
2	M		1				2	1	1
	F	1	1					3	
3	M					2		2	1
	F				3		1		1
4	M				2	1		2	
	F		1	1			1	2	
5	M		1					1	3
	F						3	2	
6	M		3		2				
	F		1		1			2	1
ALL STIMULUS ORDERS	M	0	5	0	5	3	4	7	6
	F	1	3	1	6	0	5	11	3
M&F Freq.		1	8	1	11	3	9	18	9
%		2	13	2	18	5	15	30	15

ALL PAIR ORDERS

STIMULUS ORDERS		1	2	3	4	5	6	7	8
1	M	1	3	1	3	3	3	4	2
	F	0	1	0	5	4	1	7	2
2	M	0	2	2	4	0	3	6	3
	F	2	4	0	5	0	1	7	1
3	M	0	3	0	4	4	0	6	3
	F	0	6	0	5	1	1	4	3
4	M	0	3	1	7	3	1	5	0
	F	1	3	1	4	3	1	7	0
5	M	1	4	0	2	0	2	7	4
	F	2	1	0	1	0	7	7	2
6	M	2	6	2	3	2	0	5	0
	F	0	4	1	3	0	0	11	1
ALL STIMULUS ORDERS	M	4	21	6	23	12	9	33	12
	F	5	19	2	23	8	11	43	9

ALL PAIR ORDERS (frequencies)

STIMULUS ORDERS	1	2	3	4	5	6	7	8
1	1	4	1	8	7	4	11	4
2	2	6	2	9	0	4	13	4
3	0	9	0	9	5	1	10	6
4	1	6	2	11	6	2	12	0
5	3	5	0	3	0	9	14	6
6	2	10	3	6	2	0	16	1
TOTAL FREQUENCIES	9	40	8	46	20	20	76	21

n = 240

ALL PAIR ORDERS (percent)

STIMULUS ORDERS	1	2	3	4	5	6	7	8
1	3	10	3	20	18	10	28	10
2	5	15	5	23	0	10	33	10
3	0	23	0	23	13	3	25	15
4	3	15	5	28	15	5	30	0
5	8	13	0	8	0	23	35	15
6	5	25	8	15	5	0	40	3
TOTALS AS %	4	17	3	19	8	8	32	9

AGE 2

PAIR ORDERS

Pair order 2

STIMULUS ORDERS		1	2	3	4	5	6	7	8
1	M		2			1		2	
	F		1				1	2	1
2	M				1	1	2	1	
	F	1			2			2	
3	M		1		2			2	
	F				3			1	1
4	M		1		2			1	1
	F				2		1	2	
5	M		2		2			1	
	F	1	1	1	1			1	
6	M			1	2			2	
	F		1			1		2	1
ALL STIMULUS ORDERS	M	0	6	1	9	2	2	9	1
	F	2	3	1	8	1	2	10	3
M&F Freq.		2	9	2	17	3	4	19	4
%		3	15	3	28	5	7	32	7

Pair order 3

STIMULUS ORDERS		1	2	3	4	5	6	7	8
1	M		1		3			1	
	F			1	2	1		1	
2	M		3	1	1				
	F		1			1	1	1	1
3	M		1			1		3	
	F		1		2			1	1
4	M		1		1	2		1	
	F		2		1		1	1	
5	M	2			1	1		1	
	F	1	1		1			2	
6	M				1	1		3	
	F				2	1		2	
ALL STIMULUS ORDERS	M	2	6	1	7	5	0	9	0
	F	1	5	1	8	3	2	8	2
M&F Freq.		3	11	2	15	8	2	17	2
%		5	18	3	25	13	3	28	3

Pair order 6

STIMULUS ORDERS		1	2	3	4	5	6	7	8
1	M			1		2		2	
	F	1	2				1	1	
2	M		1		3			1	
	F					1	1	2	1
3	M		2			1		1	1
	F		1		1			2	1
4	M		1		1	1	1	1	
	F		2				2	1	
5	M	2			3				
	F		2		2		1		
6	M		2		1	1		1	
	F		1			2		1	1
ALL STIMULUS ORDERS	M	2	6	1	8	5	1	6	1
	F	1	8	0	3	3	5	7	3
M&F Freq.		3	14	1	11	8	6	13	4
%		5	23	2	18	13	10	22	7

Pair order 7

STIMULUS ORDERS		1	2	3	4	5	6	7	8
1	M				2	1		1	1
	F		1		1	2		1	
2	M		1		1		1	2	
	F		1		1	1		2	
3	M		2		1			2	
	F	1	1	1				2	
4	M		1		2	1		1	
	F				4	1			
5	M		2				1	1	1
	F			1				2	2
6	M		1		1			2	1
	F		2		2			1	
ALL STIMULUS ORDERS	M	0	7	0	7	2	2	9	3
	F	1	5	2	8	4	0	8	2
M&F Freq.		1	12	2	15	6	2	17	5
%		2	20	3	25	10	3	28	8

ALL PAIR ORDERS

STIMULUS ORDERS		1	2	3	4	5	6	7	8
1	M	0	3	1	5	4	0	6	1
	F	1	4	1	3	3	2	5	1
2	M	0	5	1	6	1	3	4	0
	F	1	2	0	3	3	2	7	2
3	M	0	6	0	3	2	0	8	1
	F	1	3	1	6	0	0	6	3
4	M	0	4	0	6	4	1	4	1
	F	0	4	0	7	1	4	4	0
5	M	4	4	0	6	1	1	3	1
	F	2	4	2	4	0	1	5	2
6	M	0	3	1	5	2	0	8	1
	F	0	4	0	4	4	0	6	2
ALL STIMULUS ORDERS	M	4	25	3	31	14	5	33	5
	F	5	21	4	27	11	9	33	10

ALL PAIR ORDERS (frequencies)

STIMULUS ORDERS	1	2	3	4	5	6	7	8
1	1	7	2	8	7	2	11	2
2	1	7	1	9	4	5	11	2
3	1	9	1	9	2	0	14	4
4	0	8	0	13	5	5	8	1
5	6	8	2	10	1	2	8	3
6	0	7	1	9	6	0	14	3

TOTAL FREQUENCIES

1	2	3	4	5	6	7	8
9	46	7	58	25	14	66	15

n = 240

ALL PAIR ORDERS (percent)

STIMULUS ORDERS	1	2	3	4	5	6	7	8
1	3	18	5	20	18	5	28	5
2	3	18	3	23	10	13	28	5
3	3	23	3	23	5	0	35	10
4	0	20	0	33	13	13	20	3
5	15	20	5	25	3	5	20	8
6	0	18	3	23	15	0	35	8

TOTALS AS %

1	2	3	4	5	6	7	8
4	19	3	24	10	6	28	6

AGE 3

PAIR ORDERS

Pair order 2

Stimulus orders		1	2	3	4	5	6	7	8
1	M			1	1	1		2	
	F	1		1	2	1			
2	M	1	1			1	1		1
	F	1	1			1		1	1
3	M	1					2	1	1
	F		1	1	1			2	
4	M	1			1	2		1	
	F		1		2	1		1	
5	M	1			1	1			2
	F				2			3	
6	M				2			2	1
	F	1	2		1				1
ALL STIMULUS ORDERS	M	4	1	1	5	5	3	6	5
	F	3	5	2	8	3	0	7	2
M&F Freq.		7	6	3	13	8	3	13	7
%		12	10	5	22	13	5	22	12

Pair order 3

Stimulus orders		1	2	3	4	5	6	7	8
1	M	1			1	1	1	1	
	F		1			1		1	2
2	M	2				2	1		
	F		1				1	3	
3	M	1	1				1	1	1
	F		1		1	2		1	
4	M			1	3		1		
	F	1			1		1	2	
5	M		2		2		1		
	F		1	1		2	1		
6	M		3					2	
	F	1		1	1	1	1		
ALL STIMULUS ORDERS	M	4	6	1	6	3	5	4	1
	F	2	4	2	3	6	4	7	2
M&F Freq.		6	10	3	9	9	9	11	3
%		10	17	5	15	15	15	18	5

Pair order 6

Stimulus orders		1	2	3	4	5	6	7	8
1	M		1		1	1		2	
	F	1	1		2		1		
2	M	2		1		1	1		
	F		2			1		1	1
3	M		1		3				1
	F	1	1					2	1
4	M	1	1		2			1	
	F	1	1		1		1	1	
5	M	1	1		1			2	
	F		1			1		2	1
6	M		1		2	1	1		
	F		1	1	1	2			
ALL STIMULUS ORDERS	M	4	5	1	9	3	2	5	1
	F	3	7	1	4	4	2	6	3
M&F Freq.		7	12	2	13	7	4	11	4
%		12	20	3	22	12	7	18	7

Pair order 7

Stimulus orders		1	2	3	4	5	6	7	8
1	M		1				1	2	1
	F	1	1		1	1	1		
2	M		1			2		2	
	F			1	1	2		1	
3	M		1		1	2		1	
	F				1	4			
4	M				2	1	2		
	F		1			3		1	
5	M		1	1		1		2	
	F	1			2	2			
6	M	1	2			2			
	F		1	1		2			1
ALL STIMULUS ORDERS	M	1	6	1	3	8	3	7	1
	F	2	3	2	5	14	1	2	1
M&F Freq.		3	9	3	8	22	4	9	2
%		5	15	5	13	37	7	15	3

ALL PAIR ORDERS

Stimulus orders		1	2	3	4	5	6	7	8
1	M	1	2	1	3	3	2	7	1
	F	3	3	1	5	3	2	1	2
2	M	5	2	1	0	6	3	2	1
	F	1	4	1	1	4	1	6	2
3	M	2	3	0	4	2	3	3	3
	F	1	3	1	3	6	0	5	1
4	M	2	1	1	8	3	3	2	0
	F	2	3	0	4	4	2	5	0
5	M	2	4	1	4	2	1	4	2
	F	1	2	1	4	5	1	5	1
6	M	1	6	0	4	3	1	4	1
	F	2	4	3	3	5	1	0	2
ALL STIMULUS ORDERS	M	13	18	4	23	19	13	22	8
	F	10	19	7	20	27	7	22	8

ALL PAIR ORDERS (frequencies)

Stimulus orders	1	2	3	4	5	6	7	8
1	4	5	2	8	6	4	8	3
2	6	6	2	1	10	4	8	3
3	3	6	1	7	8	3	8	4
4	4	4	1	12	7	5	7	0
5	3	6	2	8	7	2	9	3
6	3	10	3	7	8	2	4	3

ALL PAIR ORDERS (percent)

Stimulus orders	1	2	3	4	5	6	7	8
1	10	13	5	20	15	10	20	8
2	15	15	5	3	25	10	20	8
3	8	15	3	18	20	8	20	10
4	10	10	3	30	18	13	18	0
5	8	15	5	20	18	5	23	8
6	8	25	8	18	20	5	10	8

TOTAL FREQUENCIES

1	2	3	4	5	6	7	8
23	37	11	43	46	20	44	16

n = 240

TOTALS AS %

1	2	3	4	5	6	7	8
10	15	5	18	19	8	18	7

Distributions of preference responses of 720 children for all paired comparisons of three colors. Responses are shown as given to colors in the six stimulus orders used in the study.

STIMULUS ORDERS — ALL PAIR ORDERS

Stimulus Order		1	2	3	4	5	6	7	8
1	M	2	8	3	11	10	5	17	4
	F	4	8	2	13	10	5	13	5
2	M	5	9	4	10	7	9	12	4
	F	4	10	1	9	7	4	20	5
3	M	2	12	0	11	8	3	17	7
	F	2	12	2	14	7	1	15	7
4	M	2	8	2	21	10	5	11	1
	F	3	10	1	15	8	7	16	0
5	M	7	12	1	12	3	4	14	7
	F	5	7	3	9	5	9	17	5
6	M	3	15	3	12	7	1	17	2
	F	2	12	4	10	9	1	17	5

ALL PAIR ORDERS (frequencies)

Stimulus Order	1	2	3	4	5	6	7	8
1	6	16	5	24	20	10	30	9
2	9	19	5	19	14	13	32	9
3	4	24	2	25	15	4	32	14
4	5	18	3	36	18	12	27	1
5	12	19	4	21	8	13	31	12
6	5	27	7	22	16	2	34	7

ALL PAIR ORDERS (percent)

Stimulus Order	1	2	3	4	5	6	7	8	
1	5	13	4	20	17	8	25	8	120 Ss
2	8	16	4	16	12	11	27	8	120 Ss
3	3	20	2	21	13	3	27	12	120 Ss
4	4	15	3	30	15	10	23	1	120 Ss
5	10	16	3	18	7	11	26	10	120 Ss
6	4	23	6	18	13	2	28	6	120 Ss

TOTALS

	1	2	3	4	5	6	7	8
FREQUENCIES	41	123	26	147	91	54	186	52
PERCENT	6	17	4	20	13	8	26	7

720 Ss

Distributions of preference responses of 720 children for all paired comparisons of three colors. Responses are shown as given to colors in the four pair orders used in the study.

3

	1	2	3	4	5	6	7	8
M	9	18	5	18	13	6	20	1
F	6	14	4	15	12	9	25	5
totals	15	32	9	33	25	15	45	6
percent	8	18	5	18	14	8	25	3

180 Ss

6

	1	2	3	4	5	6	7	8
M	6	16	3	26	9	5	20	5
F	4	20	1	14	9	8	24	10
totals	10	36	4	40	18	13	44	15
percent	6	20	2	22	10	7	24	8

180 Ss

2

	1	2	3	4	5	6	7	8
M	5	12	4	18	10	7	25	9
F	6	14	3	22	7	4	28	6
totals	11	26	7	40	17	11	53	15
percent	6	14	4	22	9	6	29	8

180 Ss

7

	1	2	3	4	5	6	7	8
M	1	18	1	15	13	9	23	10
F	4	11	5	19	18	6	21	6
totals	5	29	6	34	31	15	44	16
percent	3	16	3	19	17	8	24	9

180 Ss

	1	2	3	4	5	6	7	8
TOTAL FREQUENCIES	41	123	26	147	91	54	186	52
TOTALS AS %	6	17	4	20	13	8	26	7

720 Ss

Appendix D

Summary of Chi Square tests comparing forms of preference responses of children of three ages for all paired comparisons of three colors. Forms of response are shown in Tables 1 and 6.

I. List of Chi Square Comparisons

1. Forms 1+3+5+7 and 2+4+6+8 for the three age groups. (n.s.)
2. Forms 1+3+5+7 and 2+4+6+8 with the three ages combined. (n.s.)
3. Forms 1+3+5+7 and 2+4+6+8 for age one. (n.s.)
4. Forms 1+3+5+7 and 2+4+6+8 for age two. (n.s.)
5. Forms 1+3+5+7 and 2+4+6+8 for age three. (n.s.)
6. Forms 1+3 and 5+7 for the three age groups. ($P<.05$)
7. Forms 1+3 and 5+7 with the three ages combined. ($P<.001$)
8. Forms 1+3 and 5+7 for age one. ($P<.001$)
9. Forms 1+3 and 5+7 for age two. ($P<.001$)
10. Forms 1+3 and 5+7 for age three. ($P<.001$)
11. Forms 2+4 and 6+8 for the three age groups. (n.s.)
12. Forms 2+4 and 6+8 with the three ages combined. ($P<.001$)
13. Forms 2+4 and 6+8 for age one. ($P<.001$)
14. Forms 2+4 and 6+8 for age two. ($P<.001$)
15. Forms 2+4 and 6+8 for age three. ($P<.001$)
16. Forms 1 and 3 for the three age groups. (n.s.)
17. Forms 1 and 3 with the three ages combined. (n.s.)
18. Forms 1 and 3 for age one. (n.s.)
19. Forms 1 and 3 for age two. (n.s.)
20. Forms 1 and 3 for age three. ($P<.05$)
21. Forms 5 and 7 for the three age groups. ($P<.001$)

22. Forms 5 and 7 for ages one and two combined and age three. (P<.001)
23. Forms 5 and 7 with the three ages combined. (P<.001)
24. Forms 5 and 7 for age one. (P<.001)
25. Forms 5 and 7 for age two. (P<.001)
26. Forms 5 and 7 for age three. (n.s.)
27. Forms 6 and 8 for the three age groups. (n.s.)
28. Forms 6 and 8 for ages one and two combined and age three. (n.s.)
29. Forms 6 and 8 with the three ages combined. (n.s.)
30. Forms 6 and 8 for age one. (n.s.)
31. Forms 6 and 8 for age two. (n.s.)
32. Forms 6 and 8 for age three. (n.s.)
33. Forms 2 and 4 for the three age groups. (n.s.)
34. Forms 2 and 4 with the three ages combined. (n.s.)
35. Forms 2 and 4 for age one. (n.s.)
36. Forms 2 and 4 for age two. (n.s.)
37. Forms 2 and 4 for age three. (n.s.)
38. Forms 1+2+3+4 and 5+6+7+8 for the three age groups. (n.s.)
39. Forms 1+2+3+4 and 5+6+7+8 for ages one and two combined and age three. (n.s.)
40. Forms 1+2+3+4 and 5+6+7+8 for ages one and three. (n.s.)
41. Forms 1+2+3+4 and 5+6+7+8 with the three ages combined. (n.s.)
42. Forms 5+7 and 1+3 compared with forms 6+8 and 2+4 with the three ages combined. (P<.001)
43. Choice of x or y in first pair compared with second choice preference for the new color or color x. Forms 5+7 and 1+3 compared with 2+4 and 6+8 with the three ages combined. (P<.01)

44. Forms 5+7 and 1+3 compared with 2+4 and 6+8 for age one. (P<.01)

45. Forms 5+7 and 1+3 compared with 2+4 and 6+8 for age two. (n.s.)

46. Forms 5+7 and 1+3 compared with 2+4 and 6+8 for age three. (n.s.)

47. Forms 7+8 and 1+2+3+4+5+6 for the three age groups. (P<.01)

48. Forms 7+8 and 1+2+3+4+5+6 with the three ages combined. (P<.001)

49. Forms 7+8 and 1+2+3+4+5+6 for age one. (P<.001)

50. Forms 7+8 and 1+2+3+4+5+6 for age two. (P<.01)

51. Forms 7+8 and 1+2+3+4+5+6 for age three. (n.s.)

52. Forms 7 and 1+2+3+4+5+6+8 for the three age groups. (P<.01)

53. Forms 7 and 1+2+3+4+5+6+8 with the three ages combined. (P<.001)

54. Forms 7 and 1+2+3+4+5+6+8 for age one. (P<.001)

55. Forms 7 and 1+2+3+4+5+6+8 for age two. (P<.001)

56. Forms 7 and 1+2+3+4+5+6+8 for age three. (P<.001)

57. Forms 8 and 1+2+3+4+5+6+7 for the three age groups. (n.s.)

58. Forms 8 and 1+2+3+4+5+6+7 with the three ages combined. (P<.001)

59. Forms 8 and 1+2+3+4+5+6+7 for age one. (n.s.)

60. Forms 8 and 1+2+3+4+5+6+7 for age two. (P<.01)

61. Forms 8 and 1+2+3+4+5+6+7 for age three. (P<.01)

62. Forms 5+6 and 7+8 for the three age groups. (P<.001)

63. Forms 5+6 and 7+8 for ages one and two combined compared with age three. (P<.001)

64. Forms 5+6 and 7+8 for ages one and two. (n.s.)

65. Forms 5+6 and 7+8 with the three ages combined. (P<.001)

66. Forms 5+6 and 7+8 for age one. (P<.001)

67. Forms 5+6 and 7+8 for age two. (P<.001)

68. Forms 5+6 and 7+8 for age three. (n.s.)

69. Forms 1+4+6+7 and 2+3+5+8 for the three age groups. (n.s.)

70. Forms 1+4+6+7 and 2+3+5+8 with the three ages combined. ($P<.001$)

71. Forms 1+4+6+7 and 2+3+5+8 for age one. ($P<.001$)

72. Forms 1+4+6+7 and 2+3+5+8 for age two. ($P<.001$)

73. Forms 1+4+6+7 and 2+3+5+8 for age three. (n.s.)

74. Forms 1, 3, 5, and 7 for the three age groups. ($P<.001$)

    a. Forms 1+7 and 3+5. ($P<.01$)

    b. Forms 1+3 and 5+7. ($P<.05$)

    c. Interaction. ($P<.05$)

75. The eight response forms for the three age groups. ($P<.001$)

76. The eight response forms for the two sexes with the three ages combined. (n.s.)

77. The eight response forms for the sex stimulus orders with the three ages combined. (n.s.)

78. The eight response forms for the four pair orders with the three ages combined. (n.s.)

II. Chi Square Summaries

1. Comparison of response forms 1+3+5+7 and 2+4+6+8 for the three age groups.

	forms 1+3+5+7	forms 2+4+6+8	Totals
Age 1	113 (114.67)	127 (125.33)	240
Age 2	107 (114.67)	133 (125.33)	240
Age 3	124 (114.67)	116 (125.33)	240
Totals	344	376	720

$\chi^2 = 2.47$, d.f. = 2, $.20<P<.30$, n.s.

2. Comparison of response forms 1+3+5+7 and 2+4+6+8 with ages combined.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+3+5+7	344	360	-16	256	.71
Forms 2+4+6+8	376	360	16	256	.71
	720				$\sum$=1.42

$\chi^2 = 1.42$, d.f. = 1, $.20<P<.30$, n.s.

3. Comparison of response forms 1+3+5+7 and 2+4+6+8 for age one.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+3+5+7	113	120	-7	49	.41
Forms 2+4+6+8	127	120	7	49	.41
	240				$\sum$=.82

$\chi^2 = .82$, d.f. = 1, $.30<P<.50$, n.s.

4. Comparison of response forms 1+3+5+7 and 2+4+6+8 for age two.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+3+5+7	107	120	-13	169	1.41
Forms 2+4+6+8	133	120	13	169	1.41
	240				$\sum$=2.82

$\chi^2 = 2.82$, d.f. = 1, $.05<P<.10$, n.s.

5. Comparison of response forms 1+3+5+7 and 2+4+6+8 for age three.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+3+5+7	124	120	4	16	.13
Forms 2+4+6+8	116	120	-4	16	.13
	240				$\sum$=.26

χ^2 = .26, d.f. = 1, .50<P<.70, n.s.

6. Comparison of response forms 1+3 and 5+7 for the three age groups.

	forms 1+3	forms 5+7	Totals
Age 1	17 (22.01)	96 (90.99)	113
Age 2	16 (20.84)	91 (86.16)	107
Age 3	34 (24.15)	90 (99.85)	124
Totals	67	277	344

χ^2 = 7.80, d.f. = 2, P<.05

7. Comparison of response forms 1+3 and 5+7 with ages combined.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+3	67	172	-105	11025	64.1
Forms 5+7	277	172	105	11025	64.1
	344				$\sum$=128.2

χ^2 = 128.2, d.f. = 1, P<.001

8. Comparison of response forms 1+3 and 5+7 for age one.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+3	17	56.5	-39.5	1560.25	27.62
Forms 5+7	96	56.5	39.5	1560.25	27.62
	113				$\sum$=55.24

χ^2 = 55.24, d.f. = 1, P<.001

9. Comparison of response forms 1+3 and 5+7 for age two.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+3	16	53.5	-37.5	1046.25	26.29
Forms 5+7	91	53.5	37.5	1046.25	26.29
	107				$\sum$=52.58

χ^2 = 52.58, d.f. = 1, $P<.001$

10. Comparison of response forms 1+3 and 5+7 for age three.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+3	34	62	-28	784	12.65
Forms 5+7	90	62	28	784	12.65
	124				$\sum$=25.30

χ^2 = 25.30, d.f. = 1, $P<.001$

11. Comparison of response forms 2+4 and 6+8 for the three age groups.

	forms 2+4	forms 6+8	Totals
Age 1	86 (91.2)	41 (35.8)	127
Age 2	104 (95.51)	29 (37.49)	133
Age 3	80 (83.3)	36 (32.7)	116
Totals	270	106	376

χ^2 = 4.19, d.f. = 2, $.10<P<.20$, n.s.

12. Comparison of response forms 2+4 and 6+8 with ages combined.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 2+4	270	188	82	6724	35.77
Forms 6+8	106	188	-82	6724	35.77
	376				$\sum$=71.54

χ^2 = 71.54, d.f. = 1, $P<.001$

13. Comparison of response forms 2+4 and 6+8 for age one.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 2+4	86	63.5	22.5	506.25	7.97
Forms 6+8	41	63.5	-22.5	506.25	7.97
	127				$\sum$=15.94

$\chi^2 = 15.94$, d.f. = 1, $P<.001$

14. Comparison of response forms 2+4 and 6+8 for age two.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 2+4	104	66.5	37.5	1406.25	21.15
Forms 6+8	29	66.5	-37.5	1406.25	21.15
	133				$\sum$=42.30

$\chi^2 = 42.30$, d.f. = 1, $P<.001$

15. Comparison of response forms 2+4 and 6+8 for age three.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 2+4	80	58	22	484	8.34
Forms 6+8	36	58	-22	484	8.34
	116				$\sum$=16.68

$\chi^2 = 16.68$, d.f. = 1, $P<.001$

16. Comparison of response forms 1 and 3 for the three age groups.

	form 1	form 3	Totals
Age 1	9 (10.4)	8 (6.6)	17
Age 2	9 (9.79)	7 (6.21)	16
Age 3	23 (20.81)	11 (13.19)	34
Totals	41	26	67

$\chi^2 = 1.24$, d.f. = 2, $.50<P<.70$, n.s.

17. Comparison of response forms 1 and 3 with ages combined.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 1	41	33.5	7.5	56.25	1.68
Form 3	26	33.5	-7.5	56.25	1.68
	67				$\sum$=3.36

χ^2 = 3.36, d.f. = 1, .05<P<.10, n.s.

18. Comparison of response forms 1 and 3 for age one.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 1	9	8.5	.50	.25	.03
Form 3	8	8.5	-.50	.25	.03
	17				$\sum$=.06

χ^2 = .06, d.f. = 1, .80<P<.90, n.s.

19. Comparison of response forms 1 and 3 for age two.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 1	9	8	1	1	.13
Form 3	7	8	-1	1	.13
	16				$\sum$=.26

χ^2 = .26, d.f. = 1, .50<P<.70, n.s.

20. Comparison of response forms 1 and 3 for age three.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 1	23	17	6	36	2.12
Form 3	11	17	-6	36	2.12
	34				$\sum$=4.24

χ^2 = 4.24, d.f. = 1, P<.05

21. Comparison of response forms 5 and 7 for the three age groups.

	form 5	form 7	Totals
Age 1	20 (31.54)	76 (64.46)	96
Age 2	25 (29.90)	66 (61.1)	91
Age 3	46 (29.57)	44 (60.43)	90
Totals	91	186	277

$\chi^2 = 21.08$, d.f. = 2, $P<.001$

22. Comparison of response forms 5 and 7 for age groups 1+2 and age group 3.

	form 5	form 7	Totals
Ages 1 and 2	45 (61.43)	142 (125.57)	187
Age 3	46 (29.57)	44 (60.43)	90
Totals	91	186	277

$\chi^2 = 20.14$, d.f. = 1, $P<.001$

23. Comparison of response forms 5 and 7 with ages combined.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 5	91	138.5	-47.5	2256.25	16.29
Form 7	186	138.5	47.5	2256.25	16.29
	277				$\sum=32.58$

$\chi^2 = 32.58$, d.f. = 1, $P<.001$

24. Comparison of response forms 5 and 7 for age one.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 5	20	48	-28	784	16.33
Form 7	76	48	28	784	16.33
	96				$\sum=32.66$

$\chi^2 = 32.66$, d.f. = 1, $P<.001$

25. Comparison of response forms 5 and 7 for age two.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 5	25	45.5	-20.5	420.25	9.24
Form 7	66	45.5	20.5	420.25	9.24
	91				$\sum$=18.48

$\chi^2 = 18.48$, d.f. = 1, $P<.001$

26. Comparison of response forms 5 and 7 for age three.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 5	46	45	1	1	.02
Form 7	44	45	-1	1	.02
	90				$\sum$=.04

$\chi^2 = .04$, d.f. = 1, $.80<P<.90$, n.s.

27. Comparison of response forms 6 and 8 for the three age groups.

	form 6	form 8	Totals
Age 1	20 (20.89)	21 (20.11)	41
Age 2	14 (14.77)	15 (14.23)	29
Age 3	20 (18.34)	16 (17.66)	36
Totals	54	52	106

$\chi^2 = .47$, d.f. = 2, $.70<P<.80$, n.s.

28. Comparison of response forms 6 and 8 for age groups one and two combined and age group three.

	form 6	form 8	Totals
Ages 1 and 2	34 (35.66)	36 (34.34)	70
Age 3	20 (18.34)	16 (17.66)	36
Totals	54	52	106

$\chi^2 = .47$, d.f. = 1, $.30<P<.50$, n.s.

29. Comparison of response forms 6 and 8 with ages combined.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 6	54	53	1	1	.02
Form 8	52	53	-1	1	.02
	106				$\sum$=.04

χ^2 = .04, d.f. = 1, .80<P<.90, n.s.

30. Comparison of response forms 6 and 8 for age one.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 6	20	20.5	-.5	.25	.01
Form 8	21	20.5	.5	.25	.01
	41				$\sum$=.02

χ^2 = .02, d.f. = 1, .80<P<.90, n.s.

31. Comparison of response forms 6 and 8 for age two.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 6	14	14.5	-.5	.25	.02
Form 8	15	14.5	.5	.25	.02
	29				$\sum$=.04

χ^2 = .04, d.f. = 1, .80<P<.90, n.s.

32. Comparison of response forms 6 and 8 for age three.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 6	20	18	2	4	.22
Form 8	16	18	-2	4	.22
	36				$\sum$=.44

χ^2 = .44, d.f. = 1, .50<P<.70, n.s.

33. Comparison of response forms 2 and 4 for the three age groups.

	form 2	form 4	Totals
Age 1	40 (39.18)	46 (46.82)	86
Age 2	46 (47.38)	58 (56.62)	104
Age 3	37 (36.44)	43 (43.56)	80
Totals	123	147	270

χ^2 = .12, d.f. = 2, .90<P<.1.0, n.s.

34. Comparison of response forms 2 and 4 with ages combined.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 2	123	135	-12	144	1.07
Form 4	147	135	12	144	1.07
	270				$\sum$=2.14

χ^2 = 2.14, d.f. = 1, .10<P<.20, n.s.

35. Comparison of response forms 2 and 4 for age one.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 2	40	43	-3	9	.21
Form 4	46	43	3	9	.21
	86				$\sum$=.42

χ^2 = .42, d.f. = 1, .50<P<.70, n.s.

36. Comparison of response forms 2 and 4 for age two.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 2	46	52	-6	36	.69
Form 4	58	52	6	36	.69
	104				$\sum$=1.38

χ^2 = 1.38, d.f. = 1, .20<P<.30, n.s.

37. Comparison of response forms 2 and 4 for age three.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 2	37	40	-3	9	.23
Form 4	43	40	+3	9	.23
	80				$\sum = .46$

$\chi^2 = .46$, d.f. = 1, P = .50, n.s.

38. Comparison of response forms 1+2+3+4 and 5+6+7+8 for the three age groups.

	forms 1-4	forms 5-8	Totals
Age 1	103 (112.33)	137 (127.67)	240
Age 2	120 (112.33)	120 (127.67)	240
Age 3	114 (112.33)	126 (127.67)	240
Totals	337	383	720

$\chi^2 = 2.47$, d.f. = 2, $.20<P<.30$, n.s.

39. Comparison of response forms 1+2+3+4 and 5+6+7+8 for age groups one and two combined and age group three.

	forms 1-4	forms 5-8	Totals
Ages 1 and 2	223 (224.67)	257 (255.33)	480
Age 3	114 (112.33)	126 (127.67)	240
Totals	337	383	720

$\chi^2 = .06$, d.f. = 1, $.70<P<.80$, n.s.

40. Comparison of response forms 1+2+3+4 and 5+6+7+8 for age groups one and three.

	forms 1-4	forms 5-8	Totals
Age 1	103 (108.5)	137 (131.5)	240
Age 3	114 (108.5)	126 (131.5)	240
Totals	217	263	480

$\chi^2 = 1.02$, d.f. = 1, $.30<P<.50$, n.s.

41. Comparison of response forms 1+2+3+4 and 5+6+7+8 with ages combined.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1-4	337	360	-23	529	1.47
Forms 5-8	383	360	23	529	1.47
	720				$\sum=2.94$

$\chi^2 = 2.94$, d.f. = 1, $.05<P<.10$, n.s.

42. Shifting responses compared with type of shift. Comparison of response forms 5+7 and 1+3 with 6+8 and 2+4 with ages combined.

	Shift	Non-shift	Totals
Type 1 (5+7 and 1+3)	277 (182.99)	67 (161.01)	344
Type 2 (6+8 and 2+4)	106 (200.01)	270 (175.99)	376
Totals	383	337	720

$\chi^2 = 197.6$, d.f. = 1, $P<.001$

43. Choice of x or y in the first pair compared with second-pair preference for the new color or for color x.

Comparison of response forms 5+7 and 1+3 with 2+4 and 6+8 with ages combined.

	second choice preference for the new color (forms 5+7 and 2+4)	second choice preference for x (forms 1+3 and 6+8)	Totals
Choice of x in the first pair (forms 5+7 and 1+3)	277 (261.34)	67 (82.66)	344
Choice of y in the first pair (forms 2+4 and 6+8)	270 (285.66)	106 (90.34)	376
Totals	547	173	720

$\chi^2 = 7.48$, d.f. = 1, $P<.01$

44. Choice of x or y in the first pair compared with second-pair preference for the new color or for color x.

Comparison of response forms 5+7 and 1+3 with 2+4 and 6+8 for age one.

	second choice preference for the new color (forms 5+7 and 2+4)	second choice preference for x (forms 1+3 and 6+8)	Totals
Choice of x in the first pair (forms 5+7 and 1+3)	96 (85.69)	17 (27.31)	113
Choice of y in the first pair (forms 2+4 and 6+8)	86 (96.31)	41 (30.69)	127
Totals	182	58	240

$\chi^2 = 9.69$, d.f. = 1, $P<.01$

45. Choice of x or y in the first pair compared with second-pair preference for the new color or for color x.

Comparison of response forms 5+7 and 1+3 with 2+4 and 6+8 for age two.

	second choice preference for the new color (forms 5+7 and 2+4)	second choice preference for x (forms 1+3 and 6+8)	Totals
Choice of x in the first pair (forms 5+7 and 1+3)	91 (86.94)	16 (20.06)	107
Choice of y in the first pair (forms 2+4 and 6+8)	104 (108.26)	29 (24.94)	133
Totals	195	45	240

$\chi^2 = 1.84$, d.f. = 1, $.10<P<.20$, n.s.

46. Choice of x or y in the first pair compared with second-pair preference for the new color or for color x.

Comparison of response forms 5+7 and 1+3 with 2+4 and 6+8 for age three.

	second choice preference for the new color (forms 5+7 and 2+4)	second choice preference for x (forms 1+3 and 6+8)	Totals
Choice of x in the first pair (forms 5+7 and 1+3)	90 (87.83)	34 (36.17)	124
Choice of y in the first pair (forms 2+4 and 6+8)	80 (82.17)	36 (33.83)	116
Totals	170	70	240

$\chi^2 = .38$, d.f. = 1, $.50<P<.70$, n.s.

47. Intransitive response for the three age groups.

Comparison of response forms 7+8 (intransitive) with 1+2+3+4+5+6 for the three age groups.

	forms 7+8	forms 1-6	Totals
Age 1	97 (79.33)	143 (160.67)	240
Age 2	81 (79.33)	159 (160.67)	240
Age 3	60 (79.33)	180 (160.67)	240
Totals	238	482	720

$\chi^2 = 12.98$, d.f. = 2, $P<.01$

48. Intransitive response for the three ages combined.

Comparison of response forms 7+8 with 1+2+3+4+5+6 with ages combined (expectation .25/.75).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 7+8	238	180	58	3364	18.69
Forms 1-6	482	540	-58	3364	6.23
	720				Σ=24.92

$\chi^2 = 24.92$, d.f. = 1, $P<.001$

49. Intransitive response for age one. Comparison of response forms 7+8 (intransitive) with 1+2+3+4+5+6 for age one (expectation .25/.75).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 7+8	97	60	37	1369	22.82
Forms 1-6	143	180	-37	1369	7.61
	240				Σ=30.43

$\chi^2 = 30.43$, d.f. = 1, $P<.001$

50. Intransitive response for age two. Comparison of response forms 7+8 (intransitive) with 1+2+3+4+5+6 for age two (expectation .25/.75).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 7+8	81	60	21	441	7.35
Forms 1-6	159	180	-21	441	2.45
	240				Σ=9.80

$\chi^2 = 9.80$, d.f. = 1, $P<.01$

51. Intransitive response for age three. Comparison of response forms 7+8 (intransitive) with 1+2+3+4+5+6 for age three (expectation .25/.75).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 7+8	60	60	0	0	0
Forms 1-6	180	180	0	0	0
	240				$\sum=0$

$\chi^2 = 0$, n.s.

52. Intransitive form 7 responses for the three age groups. Comparison of response forms 7 with 1+2+3+4+5+6+8 for the three age groups.

	form 7	all other forms	Totals
Age 1	76 (62)	164 (178)	240
Age 2	66 (62)	174 (178)	240
Age 3	44 (62)	196 (178)	240
Totals	186	534	720

$\chi^2 = 11.66$, d.f. = 2, $P<.01$

53. Intransitive form 7 responses for the three ages combined. Comparison of response form 7 with 1+2+3+4+5+6+8 for the three ages combined (expectation $\frac{1}{8}/\frac{7}{8}$).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 7	186	90	96	9216	102.40
All other forms	534	630	-96	9216	14.63
	720				$\sum=117.03$

$\chi^2 = 117.03$, d.f. = 1, $P<.001$

54. Intransitive form 7 responses for age one. Comparison of response form 7 with 1+2+3+4+5+6+8 for age one (expectation $\frac{1}{8}/\frac{7}{8}$).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 7	76	30	46	2116	70.53
All other forms	164	210	-46	2116	10.08
	240				$\sum$=80.61

χ^2 = 80.61, d.f. = 1, P<.001

55. Intransitive form 7 responses for age two. Comparison of response form 7 with 1+2+3+4+5+6+8 for age two (expectation $\frac{1}{8}/\frac{7}{8}$).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 7	66	30	36	1296	43.20
All other forms	174	210	-36	1296	6.17
	240				$\sum$=49.37

χ^2 = 49.37, d.f. = 1, P<.001

56. Intransitive form 7 responses for age three. Comparison of response form 7 with 1+2+3+4+5+6+8 for age three (expectation $\frac{1}{8}/\frac{7}{8}$).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 7	44	30	14	196	6.53
All other forms	196	210	-14	196	.93
	240				$\sum$=7.46

χ^2 = 7.46, d.f. = 1, P<.01

57. Intransitive form 8 responses for the three age groups. Comparison of response form 8 with 1+2+3+4+5+6+7 for the three age groups.

	form 8	all other forms	Totals
Age 1	21 (17.33)	219 (222.67)	240
Age 2	15 (17.33)	225 (222.67)	240
Age 3	16 (17.33)	224 (222.67)	240
Totals	52	668	720

χ^2 = 1.28, d.f. = 2, .50<P<.70, n.s.

58. Intransitive form 8 responses for the three ages combined.

Comparison of response form 8 with 1+2+3+4+5+6+7 for the three ages combined (expectation $\frac{1}{8}/\frac{7}{8}$).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 8	52	90	-38	1444	16.04
All other forms	668	630	38	1444	2.29
	720				Σ=18.33

$\chi^2 = 18.33$, d.f. = 1, $P<.001$

59. Intransitive form 8 responses for age one. Comparison of response form 8 with 1+2+3+4+5+6+7 for age one (expectation $\frac{1}{8}/\frac{7}{8}$).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 8	21	30	-9	81	2.70
All other forms	219	210	9	81	.39
	240				Σ= 3.09

$\chi^2 = 3.09$, d.f. = 1, $.05<P<.10$, n.s.

60. Intransitive form 8 responses for age two. Comparison of response form 8 with 1+2+3+4+5+6+7 for age two (expectation $\frac{1}{8}/\frac{7}{8}$).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 8	15	30	-15	225	7.50
All other forms	225	210	15	225	1.07
	240				Σ=8.57

$\chi^2 = 8.57$, d.f. = 1, $P<.01$

61. Intransitive form 8 responses for age three. Comparison of response form 8 with 1+2+3+4+5+6+7 for age three (expectation $\frac{1}{8}/\frac{7}{8}$).

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Form 8	16	30	-14	196	6.53
All other forms	224	210	14	196	.93
	240				Σ=7.46

$\chi^2 = 7.46$, d.f. = 2, $P<.01$

62. Transitive and intransitive shifting responses for the three age groups. Comparison of response forms 5+6 with 7+8 for the three age groups.

	forms 5+6 (transitive)	forms 7+8 (intransitive)	Totals
Age 1	40 (51.87)	97 (85.13)	137
Age 2	39 (45.43)	81 (74.57)	120
Age 3	66 (47.70)	60 (78.30)	126
Totals	145	238	383

$\chi^2 = 17.14$, d.f. = 2, $P<.001$

63. Transitive and intransitive shifting responses for ages one and two combined compared with age three. Comparison of response forms 5+6 with 7+8 for ages one and two combined compared with age three.

	forms 5+6 (transitive)	forms 7+8 (intransitive)	Totals
Ages 1+2	79 (97.3)	178 (159.7)	257
Age 3	66 (47.7)	60 (78.3)	126
Totals	145	238	383

$\chi^2 = 16.84$, d.f. = 1, $P<.001$

64. Transitive and intransitive shifting responses for ages one and two. Comparison of response forms 5+6 with 7+8 for ages one and two.

	forms 5+6 (transitive)	forms 7+8 (intransitive)	Totals
Age 1	40 (42.11)	97 (94.89)	137
Age 2	39 (36.89)	81 (83.11)	120
Totals	79	178	257

$\chi^2 = .33$, d.f. = 1, $.50<P<.70$, n.s.

65. Transitive and intransitive shifting responses for the age groups combined. Comparison of response forms 5+6 with 7+8 for the three ages combined.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 5+6	145	191.5	46.5	2162.25	11.29
Forms 7+8	238	191.5	46.5	2162.25	11.29
	383				Σ=22.58

χ^2 = 22.58, d.f. = 1, P<.001

66. Transitive and intransitive shifting responses for age one. Comparison of response forms 5+6 with 7+8 for age one.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 5+6	40	68.5	-28.5	812.25	11.86
Forms 7+8	97	68.5	28.5	812.25	11.86
	137				Σ=23.72

χ^2 = 23.72, d.f. = 1, P<.001

67. Transitive and intransitive shifting responses for age two. Comparison of response forms 5+6 with 7+8 for age two.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 5+6	39	60	-21	441	7.35
Forms 7+8	81	60	21	441	7.35
	120				Σ=14.70

χ^2 = 14.70, d.f. = 1, P<.001

68. Transitive and intransitive shifting responses for age three. Comparison of response forms 5+6 with 7+8 for age three.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 5+6	66	63	3	9	.14
Forms 7+8	60	63	-3	9	.14
	126				Σ=.28

χ^2 = .28, d.f. = 1, .50<P<.70, n.s.

69. The preference for y or z in the last choice for the three age groups. Comparison of response forms 1+4+6+7 and 2+3+5+8 for the three age groups.

	forms 1+4+6+7	forms 2+3+5+8	Totals
Age 1	151 (142.67)	89 (97.33)	240
Age 2	147 (142.67)	93 (97.33)	240
Age 3	130 (142.67)	110 (97.33)	240
Totals	428	292	720

$\chi^2 = 4.30$ d.f. = 2 $.10<P<.20$ n.s.

70. The preference for y or z in the last choice for the three ages combined. Comparison of response forms 1+4+6+7 and 2+3+5+8 for the three ages combined.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+4+6+7	428	360	68	4624	12.84
Forms 2+3+5+8	292	360	-68	4624	12.84
	720				$\sum$=25.68

$\chi^2 = 25.68$, d.f. = 1, $P<.001$

71. The preference for y or z in the last choice for age one. Comparison of response forms 1+4+6+7 and 2+3+5+8 for age one.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+4+6+7	151	120	31	961	8.01
Forms 2+3+5+8	89	120	-31	961	8.01
	240				$\sum$=16.02

$\chi^2 = 16.02$, d.f. = 1, $P<.001$

72. The preference for y or z in the last choice for age two.

Comparison of response forms 1+4+6+7 and 2+3+5+8 for age two.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+4+6+7	147	120	27	729	6.08
Forms 2+3+5+8	93	120	-27	729	6.08
	240				Σ=12.16

χ^2 = 12.16, d.f. = 1, P<.001

73. The preference for y or z in the last choice for age three.

Comparison of response forms 1+4+6+7 and 2+3+5+8 for age three.

	f	F	f-F	$(f-F)^2$	$(f-F)^2/F$
Forms 1+4+6+7	130	120	10	100	.83
Forms 2+3+5+8	110	120	-10	100	.83
	240				Σ=1.66

χ^2 = 1.66, d.f. = 1, .10<P<.20, n.s.

74. Comparison of response forms 1, 3, 5 and 7 for the three age groups to provide an assessment of interaction of age and response to forms 1 and 7.

	Form 1	Form 3	Form 5	Form 7	Totals
Age 1	9 (13.47)	8 (8.54)	20 (29.89)	76 (61.1)	113
Age 2	9 (12.75)	7 (8.09)	25 (28.31)	66 (57.85)	107
Age 3	23 (14.78)	11 (9.37)	46 (32.8)	44 (67.05)	124
Totals	41	26	91	186	344

χ^2 - 29.28, d.f. = 6, P<.001

The six degrees of freedom for this comparison are partitioned into (a) 2 d.f. for comparison of forms 1 + 7 and forms 3 + 5; (b) 2 d.f. for comparison of forms 1 + 3 and forms 5 + 7; (c) 2 d.f. for the interaction.

74 (a) Comparison of response forms 1+7 and 3+5 for the three age groups.

	forms 1+7	forms 3+5	Totals
Age 1	85 (74.57)	28 (38.43)	113
Age 2	75 (70.61)	32 (36.39)	107
Age 3	67 (81.83)	57 (42.17)	124
	227	117	344

$\chi^2 = 13$, d.f. = 2, $P<.01$

74 (b) Comparison of response forms 1+3 and 5+7 for the three age groups (already reported): $\chi^2 = 7.80$, d.f. = 2, $P<.05$

74 (c) The interaction: $\chi^2 = 29.28 - 13 - 7.80 = 8.48$, d.f. = $6 - 2 - 2 = 2$, $P<.05$

75. Overall age comparison for the eight response forms.

response forms

	1	2	3	4	5	6	7	8	Totals
Age 1	9 (13.67)	40 (41)	8 (8.67)	46 (49)	20 (30.33)	20 (18)	76 (62)	21 (17.33)	240
Age 2	9 (13.67)	46 (41)	7 (8.67)	58 (49)	25 (30.33)	14 (18)	66 (62)	15 (17.33)	240
Age 3	23 (13.67)	37 (41)	11 (8.67)	43 (49)	46 (30.33)	20 (18)	44 (62)	16 (17.33)	240
Totals	41	123	26	147	91	54	186	52	720

$\chi^2 = 37.88$, d.f. = 14, $P<.001$

76. Sex comparison for the eight forms with the age groups combined.

response forms

	1	2	3	4	5	6	7	8	Totals
m	21 (20.5)	64 (61.5)	13 (13)	77 (73.5)	45 (45.5)	27 (27)	88 (93)	25 (26)	360
f	20 (20.5)	59 (61.5)	13 (13)	70 (73.5)	46 (45.5)	27 (27)	98 (93)	27 (26)	360
Totals	41	123	26	147	91	54	186	52	720

$\chi^2 = 1.20$, d.f. = 7, $.90<P<1.00$, n.s.

77. Comparison of the six stimulus orders and the eight response forms with the age groups combined.

response forms

Orders	1	2	3	4	5	6	7	8	Totals
1	6 (6.83)	16 (20.5)	5 (4.33)	24 (24.5)	20 (15.17)	10 (9)	30 (31)	9 (8.67)	120
2	9 (6.83)	19 (20.5)	5 (4.33)	19 (24.5)	14 (15.17)	13 (9)	32 (31)	9 (8.67)	120
3	4 (6.83)	24 (20.5)	2 (4.33)	25 (24.5)	15 (15.17)	4 (9)	32 (31)	14 (8.67)	120
4	5 (6.83)	18 (20.5)	3 (4.33)	36 (24.5)	18 (15.17)	12 (9)	27 (31)	1 (8.67)	120
5	12 (6.83)	19 (20.5)	4 (4.33)	21 (24.5)	8 (15.17)	13 (9)	31 (31)	12 (8.67)	120
6	5 (6.83)	27 (20.5)	7 (4.33)	22 (24.5)	16 (15.17)	2 (9)	34 (31)	7 (8.67)	120
Totals	41	123	26	147	91	54	186	52	720

$\chi^2 = 46.2$, d.f. = 35, $.75<P<.90$, n.s.

78. Comparison of the four pair orders and the eight response forms with the age groups combined.

response forms

Pair orders	1	2	3	4	5	6	7	8	Totals
3	15 (10.25)	32 (30.75)	9 (6.5)	33 (36.75)	25 (22.75)	15 (13.5)	45 (46.5)	6 (13)	180
6	10 (10.25)	36 (30.75)	4 (6.5)	40 (36.75)	18 (22.75)	13 (13.5)	44 (46.5)	15 (13)	180
2	11 (10.25)	26 (30.75)	7 (6.5)	40 (36.75)	17 (22.75)	11 (13.5)	53 (46.5)	15 (13)	180
7	5 (10.25)	29 (30.75)	6 (6.5)	34 (36.75)	31 (22.75)	15 (13.5)	44 (46.5)	16 (13)	180
Totals	41	123	26	147	91	54	186	52	720

$\chi^2 = 22.67$, d.f. = 21, $.30<P<.50$, n.s.

Appendix E

Forms of preference responses by 84 adults for all paired comparisons of three colors. The Munsell specifications for the colors used and the ways they were paired are shown with the data for each condition. The colors in each pair were shown in succession. The first-second position of items in pairs was randomly determined. The forms of response to which the table refers are the eight possible ways of responding to three pairs which exhaust the paired comparisons of three items. These forms are shown in Table 1.

Colors	in pair orders			forms of response 1	2	3	4	5	6	7	8	
x = 2.5 YR 6/16	1st xy	frequencies	males	1	5	1		4				n=23
y = 5.0 Y 8/14	2nd xz		females	1	2	1	3	3		1	1	
z = 2.5 G 5/12	3rd yz											
	1st yx	frequencies	males	3	1	2		3	2	2		n=21
	2nd zx		females	1	3	1		1	2			
	3rd yz											
x = 7.5 BG 5/8	1st xy	frequencies	males	3	4			2			2	n=20
y = 5.0 G 6/10	2nd xz		females	4			2		2	1		
z = 7.5 Y 7/12	3rd yz											
	1st yx	frequencies	males		2		4	1	1	1		n=20
	2nd zx		females	1	4		3	1	1		1	
	3rd yz											
	Totals	frequencies	males	7	12	3	4	10	3	3	2	
			females	7	9	2	8	5	5	2	2	
			all Ss	14	21	5	12	15	8	5	4	n=84
			%	17	25	6	14	18	10	6	5	